Committee on Publication

Barton W. Evermann

Chairman and Editor

C. Hart Merriam
A. D. Hopkins
David White
Lyman J. Briggs

PROCEEDINGS

OF THE

Washington Academy of Sciences

VOL. IX

1907

WASHINGTON
JULY, 1907–FEBRUARY, 1908

AFFILIATED SOCIETIES.

Anthropological Society of Washington.

Biological Society of Washington.

Botanical Society of Washington.

Chemical Society of Washington.

Columbia Historical Society.

Entomological Society of Washington.

Geological Society of Washington.

Medical Society of the District of Columbia.

National Geographic Society.

Philosophical Society of Washington.

Society of American Foresters.

Washington Society of the Archæological Institute of America.

Washington Society of Engineers.

2477

Press of
The New Era Printing Company
Lancaster, Pa

CONTENTS.

PAGE

The Experimental Data of the Quantitative Measurements of Electrolytic Migration; by **James W. McBain** 1

Distribution of the Subcutaneous Vessels in the Head Region of the Ganoids, Polyodon and Lepisosteus; by **Wm. F. Allen** . 79

Origin and Evolution of Angiosperms through Apospory; by **O. F. Cook** 159

Heredity and Mendel's Law; by **Charles B. Davenport** . . 179

Mendelism and other Methods of Descent; by **O. F. Cook** . . 189

Linnæan Memorial Address; by **Edward L. Greene** . . . 241

Linnæus as a Zoölogist; by **Dr. William H. Dall** . . . 272

A Review of the American Components of the Tenebrionid Subfamily Tentyriinæ; by **Thomas L. Casey** 275

Contents, Organization, Membership and Index . . . 523

ILLUSTRATIONS

PLATES

FACING PAGE

I. Dissection of Head of *Polyodon spathula* 126
II. Principal Trunks of *Polyodon spathula* 128
III. Portions of Lymphatic Trunks of *Polyodon* 130
IV. Deeper Dissection of Portions of Lymphatic Trunks of *Polyodon* 132
V. Dissections of Portions of *Lepisosteus tristœchus* and *Lepisosteus osseus* 134
VI. The same continued 136
VII. Dissection of Portion of *Lepisosteus tristœchus* 138
VIII. Dissection of Portion of *Lepisosteus osseus* 140
IX. Transverse Sections of Portions of *Lepisosteus osseus* and Branchial Arch of *Polyodon* 142
X. Dissections of Portions of *Polyodon* 144
XI. The same continued 146
XII. The same continued 148
XIII. Transverse Sections of Portions of *Polyodon* 150
XIV. The same continued 152
XV. The same continued 154

PROCEEDINGS

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. IX, PP. 1–78. JULY 31, 1907.

THE EXPERIMENTAL DATA OF THE QUANTITATIVE MEASUREMENTS OF ELECTROLYTIC MIGRATION.

TO THE END OF THE YEAR 1905.

COLLECTED AND ARRANGED BY JAMES W. McBAIN.

CONTENTS.

Introduction 2
Plan of the bibliography 3
Experimental methods 3
Accuracy of the determinations 4
Errors introduced by the use of diaphragms 5
Errors introduced by the method of calculation 7
Interpretation of the results 7
  Hydrated ions 8
  Movement of undissociated electrolyte 8
  Complex ions, hydrolysis 11
  Anomalous results 12
Qualitative experiments 12
Arrangement of the abstracts, abbreviations, etc. 14
Chronological abstract of the literature 70
Index of chemicals 76
Index of authors' names 78
Index to experiments with solvents other than water 1

INTRODUCTION.

THE following compilation is a result of a search through the literature of the subject in connection with my experimental work in 1904 at the University of Toronto on the transference numbers of the weak acids. So much time was required to find and collect the scattered papers in this field, that at the sugges-

tion of Professor W. Lash Miller I decided to compile a systematic summary of the existing data. I take this occasion of expressing to him my sincerest thanks for this suggestion, and for his valuable advice as to the arrangement of the results; and I desire also to acknowledge my indebtedness to the Carnegie Institution of Washington for the grant under which I was working.

The compilation was far advanced before I left Toronto, and the whole has been revised and brought up to date in Leipsic and Heidelberg. My thanks are due to Professor Luther for the interest he has displayed in the work, and to Professor Jahn for his kindness in furnishing me with out-of-print dissertations from his laboratory.

To make this collection has cost me many months of labor extended over the past three years; but any doubt of its usefulness is removed by the frequency with which I still chance on memoirs whose titles give no indication that they contain experiments on electrolytic migration.

PLAN OF THE BIBLIOGRAPHY.

My object is to present the results in tabular form, with enough of the experimental details to enable the reader to estimate the intrinsic value of the measurements. Hence in addition to the author, title, year, volume and page of the periodical in which the papers appeared, I have given in each case a full list of the chemicals experimented with, the concentrations of the solutions, the composition of the solvent, the nature of the electrodes, the amount of electrolysis (voltameter readings), the temperature, the change in the middle (supposedly unaltered) portions, the diaphragms employed if any, the number of experiments, and the final results; also some information as to the form and size of the apparatus, and occasional critical remarks.

The material is arranged chronologically[1]; an alphabetical index of authors, an index of chemicals, and an index to experiments made in solvents other than water, are provided. In the majority of cases, however, I have not stated the method of analysis employed, nor given the duration of the experiments (chance for diffusion).

[1] Alphabetically within the year.

EXPERIMENTAL METHODS.

The experimental methods of determining migration values are five in number: the analytical or Hittorf method (previously used by Faraday and by Daniell and Miller), the direct or meniscus-velocity method, the method based on measurement of concentration cells with and without diffusion, the method based on measurements of the limiting current density at which normal products occur at the electrodes, and the method of Nernst and Riesenfeld for two immiscible solvents with a linear distribution ratio (Verteilungscoefficient).

Of these only the first two as yet yield accurate and reliable results. The results of all five methods have been abstracted in the present bibliography.

The literature for the fourth method, mainly theoretical, is:

H. W. Weber, Wied. Ann., *7*, 469 and 536 (1879).

A. Witkowsky, ibid., *11*, 759 (1880).

C. L. Weber, Zeit. phys. Chem., *4*, 182 (1889).

Sheldon and Downing, Phys. Rev., *1*, 51 (1893).

B. Klössing, Beibl., *18*, 220 (1894).

Th. des Coudres, Wied. Ann., *57*, 232 (1896).

E. Salomon, Zeit. phys. Chem., *24*, 55 (1897); *25*, 336 (1898).

C. Ullmann, Zeit. f. Elektrochem., *3*, 516 (1897).

H. J. Sand, Phil. Mag. (6), *1*, 45 (1901); Zeit. phys. Chem., *35*, 641 (1901).

C. Christiansen, Drudes Ann., *8*, 787 (1902).

P. Straneo, Acc. dei Lincei (5), *11* (I), 58, 171 (1902).

F. G. Cottrell, Zeit. phys. Chem., *42*, 385 (1903).

U. Grassi, ibid., *44*, 360 (1903).

E. Brunner, ibid., *47*, 56 (1904).

ACCURACY OF THE DETERMINATIONS.

The accuracy of transport determinations is usually much overrated. For the better experiments of such workers as Bein, Kümmell, Loeb, and Nernst, and the best experiments of Hittorf, the results seem to be reliable to one or two units in the second decimal place; the work of Steele and Denison is more accurate. Very accurate measurements[1] have been made with

[1] Probably Tower's measurements of sulphuric acid fall in this class; the experimental details are inaccessible in Heidelberg.

four substances by Noyes and by Noyes and Sammet, and a long series has appeared from Jahn's laboratory, which are especially interesting as they are all made according to the same method; the analytical work is wonderful. Noyes has more confidence in the absolute value of his results than Jahn has in his, although the experiments of Noyes and Sammet hardly surpass the best work of Jahn's pupils. However I have copied the results of Noyes to four decimal places, while Jahn calculates his to three.

Luther[1] estimates the reliability of the best measurements as amounting to one or two units in the third decimal place; and E. Wolff,[2] one of Jahn's pupils, speaks of the "hitherto accepted limit of accuracy of one per cent." It seems much easier to obtain constant results than absolutely reliable values; the difference between the final values of two investigators is often several times as great as the maximum difference between the individual results of either.

ERRORS INTRODUCED BY THE USE OF DIAPHRAGMS.

Even in the earliest experiments the difficulty of preventing the mixing of the solutions through convection currents was met by the use of diaphragms. Faraday used a porous asbestos wick, Daniell and Miller porous earthenware, while Hittorf employed intestinal membrane in most of his measurements.

Recently Bein[3] and then Hittorf[4] investigated the influence of various membranes upon the migration values, and found that while some of them, such as earthenware, had no influence apart from cataphoresis, others changed the migration values of many substances very greatly. Nernst attempted[5] to deal with these cases by his theory of the phenomenon at the meniscus between two immiscible solvents during electrolysis, and Hittorf[6] replied; it seems to me that the objections raised by the

[1] Winkelmann's Handbuch der Physik, 2 Aufl., 1905, Bd. IV, 868. This excellent review of the subject contains also a selection of the most accurate work up to 1903, including experimental details.

[2] Dissertation, Berlin, 1903.

[3] Zeit. phys. Chem., *28*, 439 (1899).

[4] Arch. neer. (2), *6*, 671 (1901); Zeit. phys. Chem., *39*, 613 (1902); *43*, 239 (1903); Zeit. f. Elektrochem., *8*, 481 (1902).

[5] Drude's Ann., *8*, 600, 609 (1902); Zeit. f. Elektrochem., *7*, 644 (1902).

[6] Drude's Ann., *9*, 243 (1902).

latter might be removed by assuming the existence of hydrated ions.

In general it is possible to obtain good results without casting suspicion upon them by the use of membranes, as is shown by the accurate measurements of Noyes and Sammet, Jahn's pupils and others. For measuring very weak electrolytes such as acetic acid, the use of some sort of diaphragm is almost indispensable; I used bundles of glass tubes of small bore, which is cumbersome, but is otherwise free from criticism. The diaphragms which are least open to objection are cloth, cotton batting, earthenware, and agar-agar. It is unfortunate that it is just in the case of weak electrolytes where diaphragms would be most useful that cataphoresis (electric endosmosis) is most prominent. Solidified gelatine, intestinal membrane, fish-bladder, gold-beaters' skin, membrane of an egg, and parchment, are the diaphragms which exert the greatest influence upon the migration; the influence varies with the nature of the electrolyte and its concentration.

ERRORS INTRODUCED BY THE METHOD OF CALCULATION.

There are several methods of calculation in use, although only one of them is correct. Hittorf described this with the greatest clearness in his classical researches; yet of only sixteen authors besides Jahn's pupils can I say with certainty that their results were correctly calculated. In many cases the data given in the papers are not sufficient to warrant a definite expression of opinion; but it is safe to assert that of the authors who used the analytical method, not more than half calculated their results correctly.

In measuring migration we are measuring the movement of the electrolyte through the solvent; hence the calculation must be based upon a constant amount of solvent. If for example we find that before electrolysis the m grams of water in an electrode compartment contains a certain amount of electrolyte, we must determine the amount of electrolyte contained in m grams of water after electrolysis. The favorite among the other methods is to determine the amount of electrolyte in a constant volume of solution before and after electrolysis; it is evident that only

in special cases will equal volumes of solutions of different concentrations contain the same amount of solvent. Hittorf[1] picked out particular cases measured by Wiedemann and showed that the error thus introduced amounted to as much as 20 percent of the migration value; in other cases it was negligible. In very dilute solutions this error vanishes. Another method bases the calculation upon constant weight of solution; as is evident, this is always wrong. Here, again, the error is worst in concentrated solutions, and becomes negligible when the solutions are very dilute. In general, I have had to leave it to the reader to calculate whether the error introduced by wrong methods of calculation is large or not; in a few cases, however, I have made the calculation myself, and when the error was vanishingly small, I have stated that the results were correctly calculated.

Possibly the following consideration of the effect on the transport number caused by neglecting the loss of gases at the electrodes may be of use. During the passage of 96,540 coulombs 8 grams of oxygen escape, hence the amount of the constituents of the solvent at the anode appears to be 8 grams less than really was, and so the apparent migration value of the anion is increased by the number of g-mols of electrolyte contained in 8 grams of water. This holds for all electrolytes where oxygen is evolved at the anode. Similarly, the migration value of the cation obtained at the cathode where hydrogen is escaping is increased by the number of g-mols of electrolyte in one gram of water; this is generally negligible. The correction to be subtracted from the migration value of the anion found by analysis at the anode is therefore 0.008 for normal solutions and 0.0008 for decinormal solutions; similarly for the cathode analysis, one eighth as much has to be added to the migration number of the anion. These corrections are mostly negligible, but the calculation is useful as showing the absolute value of the errors introduced by the chemical processes at the electrodes. It is easy to extend it to other cases; for instance, the correction at the cathode where a metal is precipitated and not weighed, is equal to its gram-equivalent weight multiplied by the correction de-

[1] Pog. Ann., *103*, 8 (1858).

duced above for hydrogen. For a metal dissolving at the anode, where the electrode is not weighed, the correction is equal to the correction for oxygen (but taken with opposite sign) multiplied by one-eighth the gram-equivalent weight.

INTERPRETATION OF THE RESULTS.

The transport number of any component of a solution is the number of gram-equivalents of that component which enters or leaves one of the electrode compartments during the passage of 96,540 coulombs of electricity.

Hittorf has shown how in certain cases (double cyanides, stannic chloride, cadmium iodide, for instance) these transport numbers may suggest definite views as to the constitution of the electrolyte. In the following paragraphs I shall briefly discuss the bearing of transport measurements on the hypothesis of hydrated ions, and on that of the possible movement of undissociated molecules of the electrolyte; and I shall explain the methods of calculating the concentrations and mobilities of the complex ions or products of hydrolysis that may be assumed to exist in the solutions of certain salts. A few measurements which are not easily reconcilable with the prevalent theory of solutions are collected under the heading "anomalous results."

Hydrated Ions.

In a solution of sodium chloride (to take a concrete example) it is customary to assume the ions $Na^{\cdot}$ and Cl' together with water and undissociated molecules of NaCl. It is, however, possible to assume the existence of hydrated ions: $(Na+xH_2O)^{\cdot}$, and $(Cl + yH_2O)'$, or of complex ions, or even that the undissociated NaCl moves towards one of the electrodes, under the influence of a fall of potential, as colloids do.

If hydrated ions be assumed, it is evident that in calculating the transport numbers from the experimental data, allowance must be made for the water carried by them into the electrode compartments and set free at the electrodes. I have shown elsewhere[1] that this correction may be expressed by the formula $\left(\frac{l_A}{A}y - \frac{l_K}{A}x\right)C$, in which l_K and l_A represent the mobilities of

[1] Zeit. f. Elektrochemie, *11*, 216 (1905).

the cation and anion respectively, x and y the number of g-mols of water combined with one equivalent of each ion, Λ the equivalent conductivity, and C the total concentration of the electrolyte expressed as the number of g-equivs solute in one g-mol water. Thus it is evident that if the transport numbers of the hydrated ions are to be very different from those of $Na^{\cdot}$ and Cl', either the ions must differ widely in mobility and have a large amount of combined water, or the difference in hydration of the ions must be great. The numerical example given in the paper quoted shows that in general the change in the transport number caused by assuming that the ions are hydrated, is small. In very concentrated solutions, however, the difference would be greater; and the hypothesis might be checked by measuring the transport of some non-electrolyte added to the solution, choosing one which will not react with the electrolyte in question.[1]

Movement of Undissociated Electrolyte.

The fact that transport numbers for simple electrolytes are independent of the concentration discredits the hypothesis. The movement of non-electrolytes measured by Nernst, Garrard and Opperman[2] and by Morgan and Kanolt[3] corresponds to a transport number of the order of magnitude of 0.01. This is however a negligible quantity, being within the experimental error of most measurements; and the alternative assumption of hydrated ions is from other considerations very plausible.[4]

Complex Ions, Hydrolysis.

Three methods have been worked out for dealing with electrolytic solutions which are assumed to contain complex ions in equilibrium with simpler ions and undissociated molecules; the first was developed and applied by Burgess and Chapman, the other two by myself. The first and second methods are applicable to special cases only; the third is general, and may also be employed in dealing with hydrolysis.

(i) The method of Burgess and Chapman[5] is based on the

[1] Ibid., *11*, 961 (1905).
[2] Nachr. Gött. Akad., 1900, 68.
[3] Zeit. phys. Chem., *48*, 365 (1904).
[4] See Baur, Ahren's Sammlung, *8* (1903).
[5] Jour. Chem. Soc., *85*, 1305 (1904).

results of the careful study that has been devoted to solutions of iodine in potassium iodide solutions. Jakowkin and others have shown by means of several physico-chemical methods that KI_3 and KI are electrolytes of equal degree of dissociation; the dissociation constant for the reaction $\bar{I}_3 \rightleftharpoons I_2 + \bar{I}$ is also known, from these data and a transport determination in solutions containing iodine and potassium iodide the mobility of the tri-iodion was calculated, and found to agree with that calculated from conductivity measurements assuming that the dissociation of potassium tri-iodide is the same as that of potassium iodide.

(ii) In solutions of the haloid salts of cadmium and zinc the transport of the halogen increases rapidly with the concentration, and finally approaches a maximum. This may be interpreted by assuming that, when the maximum is reached, the concentration of the simple ions is negligibly small; by making suitable assumptions as to the formula of the complex its transport number may be calculated, and from the experimental numbers for intermediate concentrations the relative amounts of simple and complex ion may be obtained.

In the case of cadmium iodide[1] the numbers so arrived at are in accord with freezing point, and conductivity, and with the requirements of the mass law. The applicability of the method is restricted by the condition that, if the results are to be reliable, the maximum must be reached before the solution becomes too concentrated.

(iii) The third method is based on the assumption that in solutions containing a number of ions the migration of each is given by the product of its concentration into its migration velocity. This view was advanced by Hittorf in 1857; it has been tested and confirmed by numerous experimenters with known mixtures of two simple salts having a common ion; and it has been used in the mathematical developments of Kohlrausch.[2]

Let u, v, w, x, represent the mobilities of the ions $K^{\cdot}$, $Cd^{\cdot\cdot}$,

[1] R. Schrader, Zeit. f. Elektrochem., *3*, 498 (1897). E. v. Stackelberg, Zeit. phys. Chem., *23*, 493 (1897). K. Hopfgartner., Zeit. phys. Chem., *25*, 115 (1898). H. Jahn, Zeit. phys. Chem., *27*, 354 (1898). H. Hoffmeister, Zeit. phys. Chem., *27*, 345 (1898). E. Berliner, Dissertation, Berlin, 1902 — to appear this Winter with other work from Jahn's laboratory in the Zeit. phys. Chem.

[2] Wied. Ann., *62*, 209 (1897).

I', and CdI_3' respectively, in a solution of potassium cadmium iodide; and a, b, c, d, their concentrations expressed as gram-equivalents per cubic centimeter. Three of the mobilities, viz.: u, v, w, may be taken as known; and among the four concentrations there must exist the relation

$$a + b = c + d$$

so that four of the eight symbols, u, v, w, x, a, b, c, d, represent unknowns. Four experiments giving four independent relations involving these four are therefore necessary in order to determine the concentration of each of the ions, and the mobility of CdI_3'. Such, for example, are the following:

1. The specific conductivity $\varkappa$ may be determined; by Kohlrausch's law

$$au + bv + cw + dx = \varkappa.$$

2. The quantity of potassium which enters the cathode compartment during the passage of one faraday through the solution may be determined; it is $au/\varkappa$ equivalents.

3. Similarly, the net gain of cadmium in the anode compartment per faraday, is $(2dx - bv)/\varkappa$ equivalents.

4. And the gain of iodine at the anode per faraday: $(cw + 3dx)/\varkappa$ equivalents.

These are not the only experiments, however, that might be employed. By means of E.M.F. measurements, for instance, the concentrations b or c might be determined; the freezing point gives $a + \frac{1}{2}b + c + d$, etc. The experiments thus furnish more equations than unknowns, and the surplus may be used to check the theory. This has been done in my paper[1] in which the concentrations were calculated from transport measurements and one E.M.F. determination; the results so obtained are in accordance with the conductivity and freezing points.

It may be remarked that when the number of analytical components among the ions of a solution is represented by n, the migration of the n-th may be calculated from those of the remaining $n - 1$ by means of the stoechiometrical relations. Hence agreement between the directly measured migration of the n-th component and the calculated value is the best proof that unsuspected ions (due to hydrolysis, for example) have not been overlooked.

[1] Zeit. f. Elektrochem., 11, 961 (1905).

Anomalous Results.

Of remarkable results there are many. Highly interesting are the researches of Daniell and Miller in 1844. These well known and capable experimenters, fully alive to the significance of the results they were obtaining, found that in many cases components now recognized as cations did not move at all. Later measurements agree in showing that in these very solutions the cation moves about as fast as the anion. Hittorf and others have suggested explanations for Daniell and Miller's results, but unfortunately the explanations suggested only make things worse.

Chassy, in 1890, made a number of measurements with mixtures of two and more electrolytes. His results are summarized by Ponsot[1] and are quite at variance with the predictions of the present theory; his is the only experimental work in this field.

Bein, in 1898, found for ammonium hydroxide a transport number widely different from that predicted by Kohlrausch's law of the independent migration of the ions. In 1904 I obtained a similar result for acetic and propionic acids. These are the only measurements that have been made with very weak electrolytes, and all three obey Ostwald's law; these results should not be so difficult to believe when Jahn and Nernst hold that the mobility of an ion varies greatly with the concentration, without any more evidence than that the conductivity and freezing points which agree so well with one another both refuse to obey Ostwald's law, although the latter does not take into account the possible displacement of the equilibrium by the electrical forces.

The accurate measurements of Noyes and Sammet in 1902 gave a result for hydrochloric acid differing by four percent from that calculated from the careful conductivity measurements of Goodwin and Haskell;[2] the transference measurements have been confirmed in Jahn's laboratory by Joachim, and the divergence has to be regarded as real. Divergences equally great even amongst the most carefully measured electrolytes are so

[1] Comptes rendus, *138*, 192.

[2] Phys. Review, *19*, 369 (1904).

common, that Luther has come to the conclusion that it is not worth while discussing whether Kohlrausch's Law is strictly quantitative or not until the experimental data are more reliable.

QUALITATIVE EXPERIMENTS.

Qualitative or semi-quantitative experiments are sufficient to show whether a given component of a solution moves toward the anode or toward the cathode during electrolysis. In order that the results may be decisive as to the constitution of the solution, however, further experiments must be made to find whether or no the component in question is present in colloidal form; this has been done in recent papers from the Leipsic laboratory.

If the experiment is carried out by electrolysing the solution between two other "electrode solutions," the presence of one of the components of the intermediate solution in the cathode compartment may justly be regarded as evidence that the component in question formed a constituent of some cation; the converse, however, is not necessarily true. It is possible that the component which in the intermediate solution formed part of a cation might have acted as anion in the cathode solution, and that it was consequently, in large part at least, driven out as soon as it entered. The experiments of Richards and Bonnet in 1904, and of Lind in 1903, offer a case in point; the authors are however doubtless justified in the conclusions which they draw, for the rate of transformation of the various modifications of chromic sulphate into each other is notoriously slow.

ARRANGEMENT OF THE ABSTRACTS, ABBREVIATIONS USED.

In the following abstracts general information is given in a paragraph which does not require further explanation. In the tables, the first column gives the chemical measured; the second the concentration (m denotes mols, that is gram-formula-weights); the third the temperature; the fourth the number of grams of silver or copper deposited in the voltameter, indicated by the abbreviation "g Ag," "g Cu," etc.; the fifth the per-cent change in the composition of the middle (supposedly unaltered) portions, calculated by myself; the sixth, the number of experiments ("ex"); the next indicates which electrode solution

was analyzed, "a" denoting the anode compartment, "c" the cathode compartment, and "ac" meaning that both were analyzed and used in computing the transport number; next comes the transport number of the anion, here the cipher before the decimal point is always omitted, and the number is filled out to three decimal places by dashes when the experiments were less accurate; attached to the transport number is given half the maximum divergence (multiplied by 1,000) between the individual results, preceded by the sign ±.

Thus "23 ex a .170 ± 4" means that 23 experiments were performed, the analyses at the anode compartment were used to compute the transport, the transport number found for the anion was 0.170, the maximum divergence between the individual results was 0.008. Very inaccurate experiments would be given as follows: "5 ex ac .51 — ± 67" meaning that the transport number found is 0.51, and the difference between the two extreme results was 0.134. Noyes' results are given thus: "ac .1657 ± 2.3" meaning 0.1657 with a maximum difference between the results of 0.0046. I am convinced that this maximum divergence does not in most cases give an exaggerated impression of the inaccuracy of the experiments.

The arrangement just described is followed as far as possible; often, however, a column is left out when the data are lacking, or when they have been given in the paragraph at the top. Extra columns, special arrangements of the data, etc., are explained in each special case.

In deciding what experiments it was fair to average together, in almost all cases I have been much more tender with the results than the authors themselves; many authors show what they think of their own results by averaging together all their values, even when obtained under different conditions of temperature and concentration. When only one experiment was performed under each set of experimental conditions, I did not feel justified in averaging the results even where their accuracy seemed questionable. Thus I have tried to give the experiments the benefit of the doubt; the reader should take this into account when trying to decide in any particular case whether the transport numbers really vary with the temperature, etc., or not.

ABSTRACT OF THE LITERATURE OF ELECTROLYTIC MIGRATION.

1814. R. Porrett.

Abstracts Phil. Trans., *1*, 510, from Phil. Trans., p. 519. On the Nature of the Salts termed Triple Prussiates, and on Acids formed by the Union of certain Bodies with the Elements of Prussic Acid.

The author observed the movement of Fe and of K in the electrolysis of ferrocyanic acid solution.

1833. M. Faraday.

Experimental Researches in Electricity, fifth series, III, Theory of Electrochemical Decomposition. Phil. Trans., *123*, 682, 525–530. Ostwald's Klassiker, *86*, 85. Pogg. Ann., *32*, 436.

Two pieces of apparatus, each consisting of two electrode cups connected by a strip of asbestos, were set up in series. One was filled with sulphuric acid of specific gravity 1.0212, the other with a chemically equivalent solution of sodium sulphate. Pt electrodes were used and the contents of the four cups were weighed and titrated before and after the electrolysis. The change in acidity in each cup of the sodium sulphate apparatus was $2\frac{1}{2}$–3 times as great as in the sulphuric acid apparatus. The sulphuric acid contained a small percentage of inorganic sulphates. (From these experiments it would follow that in sulphuric acid n for SO_4 lies between .4 and .33.)

1839. J. F. Daniell.

On the Electrolysis of Secondary Compounds. In a letter addressed to M. Faraday. Phil. Trans., *129*, 97.

Apparatus: A vertical U-tube with two diaphragms of bladder in the bend; tubes were attached to collect the gases from each of the electrodes separately. The current was measured by a water voltameter. In seven electrolyses with 1–10 percent solutions of sulphuric acid the migration value of the SO_4 was found to be $n = \frac{1}{4}$. In one of these experiments a Zn anode was employed, in the others Pt electrodes were used. As a result of futher electrolyses, the author concluded that the current was carried solely by the electrolyte, and adopted Davy's formulas for the oxy-acids and their salts, and those of Berzelius for the ammonium salts.

1840. J. F. Daniell.

Second letter on the Electrolysis of Secondary Compounds. Addressed to M. Faraday. Phil. Trans., *130*, 209.

The author electrolyzed various solutions in an apparatus consisting of two electrode compartments connected to a third cell by a siphon with partitions of membrane. The total electrolysis was determined by measuring the gases evolved. The solutions in each of the three cells were analyzed. In the experiments with caustic alkalis the membranes were replaced by porous earthenware.

H_2SO_4	specific gravity 1.076	$n = \frac{1}{4}$
H_3PO_4	6–11 percent	$n = \frac{1}{4}$
KOH		$n = \frac{4}{5}$
$Ba(OH)_2$	specific gravity 1.0085	$n = \frac{4}{5}$
$Sr(OH)_2$	specific gravity 1.007	$n = \frac{2}{3}$
K_2SO_4		$n = \frac{1}{2}$

1844. J. F. Daniell and W. A. Miller.

Additional Researches on the Electrolysis of Secondary Compounds. Phil. Trans., *134*, 1; Pogg. Ann., *64*, 18.

Apparatus: a horizontal cylinder divided into three compartments by vertical partitions of bladder. The Pt electrodes were placed in the end compartments which were provided with tubes for collecting the gases evolved. A water voltameter was placed in the circuit.

Experiments with copper sulphate, zinc sulphate, and ammonium chloride showed that the cation was not moved by the current. For potassium sulphate, barium nitrate, and calcium sulphate, the migration values were respectively $n = \frac{2}{3}$, $n = \frac{5}{6}$, $n = \frac{11}{12}$. Semi-quantitative experiments showed that both ions were moved in the cases of sodium tungstate, potassium chromate, potassium arsenite, and sodium carbonate; in the case of sodium chloride the chlorine was moved in greater amount than the sodium.

Further experiments were carried out with copper sulphate, aluminium sulphate, ferric sulphate, magnesium potassium sulphate, potassium aluminium alum, potassium copper sulphate, potassium sulphocyanide, potassium cyanide, potassium ferrocyanide, potassium ferricyanide, potassium sulphate, ammonium oxalate, potassium arsenite, potassium arseniate, sodium sulphite, sodium hyposulphite, and the phosphates of sodium.

1845. **M. Pouillet.**

Note sur l'electrochimie. Comptes rendus, *20*, 1 sem., 1544.

Apparatus: a U-tube; capacity 10 c.c.; Pt electrodes; no diaphragms; no middle portion; a water voltameter.

The author found no transport of gold in solutions of gold chloride; for the chlorides of iron, manganese, and cobalt $n = .66 -$; for other chlorides n lay between .7 — and .8 —. The author deduced that the action of the electrodes is unequal owing to the positive and negative constituents of an electrolyte having electric charges opposite in sign but unequal in amount.

1853. **W. Hittorf.**

Ueber die Wanderungen der Jonen während der Elektrolyse. Pogg. Ann., *89*, 177, Ostwald's Klassiker, *21*.

Apparatus: (i) a short wide glass cylinder of which the two parts could be isolated by sliding the upper half sideways; capacity 44 c.c.; the anode consisted of the metal corresponding to the electrolyte; the cathode was of Ag. No middle portion; no diaphragms. In the second column are given the number of grams of water in which one gram of salt was dissolved.

$CuSO_4$	6.35	5°	1g Ag	i	1ex	c.724
	9.56	5°	1	i	3	c.712
	18.1	4°	0.9	i	1	c.675
	40–148	4°	0.5	i	3	c.644
	9.56	20°	1.4	i	1	c.713
$AgNO_3$	2.48	11°	1.2g Ag	i	1ex	c.468
	2.73	19°	1.9	i	1	c.478
	5.18	18°	1.1	i	1	c.495
	10.4	19°	0.5	i	1	c.51 —
	14–247	19°	0.2	i	5	c.526
Ag_2SO_4	123	17°	0.1g Ag	i	3ex	c.554
$AgC_2H_3O_2$	127	15°	0.2g Ag	i	3ex	c.373
$AgNO_3$	30.9	4°	0.2g Ag	i	2ex	c.573 in ethyl alcohol.

1856. **W. Hittorf.**

Ueber die Wanderungen der Jonen während der Elektrolyse. Pogg. Ann., *98*, 1, Ostwald's Klassiker, *21*.

Apparatus: (ii) Cathode cylinder fitted into neck of anode cylinder; capacity about 80 c.c.; Ag cathode; no middle portion; no diaphragms. (iii) Horizontal cylinder divided by two partitions of porous earthenware into three compartments. (iv) Four superposed glasses, with diaphragm of intestinal membrane (Darmhaut); the upper (cathode) vessel contained free

acid; the middle portion was tested for acid and cadmium. This apparatus (iv) was made in four sizes for solutions of different concentrations; the smallest anode vessel contained 12 c.c., the largest 238 c.c.; Pt cathode, Cd anode.

In the second column are given the number of g water in which one g of salt are dissolved.

$CuSO_4$	9.56		0.8g Ag	ii	1ex	a.716	Cu anode.
	11.6		2.0	iii	2	a.704	" "
KCl	4.85	12°	1.1g Ag	iv	1ex	a.516	
	6.61	4°	0.7	iv	2	a.516	
	18.4	7°	0.8	iv	1	a.514	
	39.4	9°	0.7	iv	2	a.515	
	254	50°	0.6	iv	2	a.515	
	449	90°	0.4	iv	1	a.503	
KBr	2.36	12°	0.7g Ag	iv	2ex	a.528	
	117	7°	0.7	iv	2	a.513	
KI	2.7–8.5	1–12°	0.8g Ag	iv	3ex	a.511	
	170.3	3°	0.4	iv	1	a.492	
K_2SO_4	12	4–12°	0.9g Ag	iv	2ex	a.500	
	413	7°	0.3	iv	2	a.498	
KNO_3	5.8	9°	0.4g Ag	iv	2ex	a.450	
$KC_2H_3O_2$	1.4–48	14°	0.7g Ag	iv	2ex	a.335	
NH_4Cl	5.28	12°	1.1g Ag	iv	1ex	a.517	
	12.2	10°	1.5	iv	1	a.514	
	28.0	10°	0.9	iv	1	a.514	
	175	7°	0.7	iv	1	a.508	

1856. G. Wiedemann.

Ueber die Bewegung der Flüssigkeiten im Kreise der geschlossenen galvanischen Säule und ihre Beziehungen zur Elektrolyse. Pogg. Ann., *99*, 177.

Apparatus: two glass jars connected by a wavy siphon, capacity 200 c.c.; Pt electrodes; no diaphragms; no middle portion. Blank experiments showed the existence of an unchanged middle portion in the cases of sodium sulphate and potassium iodide.

Hittorf, Pogg. Ann., *103*, 8, shows that the results are incorrectly calculated. In the electrolyses of the copper salts between Pt electrodes, the acid formed at the anode reached the cathode portion, and Wiedemann points out that the current was partly carried by free acid.

A further series of determinations were made using porous earthenware diaphragms, repeating the experiments with sul-

phuric acid, nitric acid, copper sulphate, copper nitrate and silver nitrate. The results when corrected for cataphoresis corresponded with the numbers obtained with the apparatus described above in which diaphragms were avoided.

The concentrations are indicated in the second column in grams of SO_4, NO_3, etc., per 100 c.c.

H_2SO_4	2–14 SO_4	1.3–2.4g Cu	3ex	ac.180 ± 6	
HNO_3	7.7 NO_3	2.0g Cu	1ex	a.148	
	4.2 NO_3	2.0	1	a.142	
KOH	2.23 K	0.6g Cu	1ex	ac.245	
	2.09 K	0.6	1	ac.215	
NaOH	3.13 Na	1.1g Cu	1ex	ac.161	
	2.63 Na	1.1	1	ac.153	
$CuSO_4$	3.67 Cu	1.4g Cu	1ex	ac.181	
	1.52 Cu	0.7	1	ac.186	
	3.17 Cu	0.5	1	ac.360	Copper anode.
	2.54 Cu	0.5	1	ac.355	" "
	1.78 Cu	0.3	1	ac.321	" "
	1.52 Cu	0.3	1	ac.339	" "
$Cu(NO_3)_2$	1.66 Cu	0.9g Cu	1ex	ac.241	
	2.72 Cu	0.9	1	ac.368	Copper anode.
$AgNO_3$	1.92 Ag	1.3g Ag	1ex	ac.236	
	2.96 Ag	1.6	1	ac.535	Silver anode.
	2.66 Ag	1.0	1	ac.521	" "
NaCl	1.94 Na	0.6g Cu	1ex	ac.378	

1857. **A. Weiske.**

Die Ueberführung des Chlors bei der Elektrolyse seiner Verbindungen mit den Metallen der Alkalien und alkalischen Erden. Pogg. Ann., *103*, 466, Habilitations Dissert.

Apparatus: two flasks connected by a straight tube with a glass cap; capacity 100 c.c.; no diaphragms; no middle portion.

The calculation is based (incorrectly) upon constant volume of solution.

The author discusses the prevalent theories of electrolysis.

KCl	1–10	percent	0.4g Ag	10ex	c.516 ± 9
NaCl	9.21	percent	0.4g Ag	4ex	c.686 ± 8
	2.86	"	0.4	4	c.685 ± 9
	0.844	"	0.2	1	c.680
$CaCl_2$	1–9	percent	0.3g Ag	9ex	c.690 ± 8
$BaCl_2$	0.5–8	percent	0.3g Ag	8ex	c.531 ± 9
$SrCl_2$	1.07	percent	0.3g Ag	4ex	c.648 ± 8
	0.757	"	0.3	3	c.650 ± 9
	0.146	"	0.2	1	c.655

1858. **W. Hittorf.**

Pogg. Ann., *103*, 1; Ostwald's Klassiker, *21*.

Apparatus: (iv) see Hittorf, 1856. In these experiments a Zn anode was used and the cathode was surrounded by a solution of potassium chloride; (v) four superposed glasses of which the uppermost contained the anode and the lowest the cathode. The cathode was bent into the form of a U-tube to permit the escape of hydrogen. Earthenware and bladder diaphragms.

In the second column are given the number of grams of water in which one gram of salt was dissolved.

KCl	5.2–5.6		1.0g Ag	iv	6ex	a.513
	98		1.0g	iv	8	a.509
	3.8–5.5		0.5	v	2	c.501
KNO_3	4.62	12°	0.6g Ag	v	1ex	c.479
	9.63	11°	0.8	v	1	c.487
	31.5	7°	0.4	v	1	c.494
	94.1	8°	0.7	v	1	c.497
$KC_2H_3O_2$	1.3–94	14°	0.8g Ag	v	3ex	c.331

In addition experiments are detailed showing that in solutions containing potassium iodide and potassium chloride both I and Cl are transported by the current.

1859. **W. Hittorf.**

Pogg. Ann., *106*, 337, 513. Ostwald's Klassiker, *23*.

Apparatus: (ii) See Hittorf, 1856. (iv) See Hittorf, 1856, for the experiments with potassium cyanide the membranes were replaced by porous earthenware; in the experiments with the alkaloid hydrochlorides the cathode was surrounded by hydrochloric acid. (v) See Hittorf, 1858. (vi) Five superposed glasses with membranes. Anode of Cd in the lowest vessel, Pt cathode in the uppermost. The anode was surrounded with a protecting solution: potassium acetate in the experiments with potassium oxalate, potassium chloride in those with potassium chromate, sodium chloride in those with sodium mono- and di-sodium phosphates, sodium nitrate in those with sodium phosphate and pyrophosphate and also with iodic acid; (vii) an anode vessel closed at the bottom with membranes was fitted to the top of the cathode U-tube; Pt electrodes. In the experi-

ments with potassium cyanide, sodium platinichloride, and potassium gold chloride, the silver anode was placed at the top and surrounded with the solution of potassium cyanide.

In the second column are given the number of grams of water in which one gram of salt was dissolved. In the sixth column are recorded the weights of the anode portions (including protecting solutions if any).

$K_2C_2O_4$	4.18		1.1g Ag	vi	26g	1ex	a	.441
$KCrO_4$	9.54		1.4g Ag	vi	23g	1ex	a	.512
$K_2Cr_2O_7$	14.6		0.4g Ag	iv	8g	1ex	a	.502
$KClO_4$	119		0.3g Ag	iv	220g	1ex	a	.463
$KClO_3$	26.6		0.4g Ag	iv	60g	1ex	a	.445
	115		0.4	iv	220g	1	a	.462
KCN	7.66		0.4g Ag	iv	12g	1ex	a	.457
	105		0.15	iv	51g	1	a	.47–
NaCl	3.47	13°	1.0g Ag	iv	11g	1ex	a	.648
	5.54	9°	0.9	iv	11g	2	a	.647
	20.7	16°	1.1	iv	33g	1	a	.634
	105	17°	0.4	iv	33g	1	a	.628
	315	6°	0.5	iv	210g	4	a	.620
NaI	22.1		0.4g Ag	iv	31g	1ex	a	.626
Na_2SO_4	11.8	9°	0.9g Ag	iv	34g	1ex	a	.641
	50.7	9°	0.6	iv	32g	1	a	.634
$NaNO_3$	2.07		1.2g Ag	iv	15g	1ex	a	.588
	2.99	9°	0.8	iv	11g	1	a	.600
	34–128	12°	0.4	iv	55–210g	4	a	.614
$NaC_2H_3O_2$	2.81	8°	1.0g Ag	iv	10g	1ex	a	.415
	7.18	13°	0.5	iv	10g	1	a	.421
	41.3	6°	1.2	iv	210g	1	a	.424
	84.6	11°	0.6	iv	210g	1	a	.443
$BaCl_2$	3.2–3.8	6–14°	1g Ag	iv	12g	4ex	a	.662
	8.39	19°	1.7	iv	35g	1	a	.642
	79.6	20°	0.4	iv	60g	1	a	.616
	126	10°	0.4	iv	211g	2	a	.614
$Ba(NO_3)_2$	16.2	8°	0.2g Ag	iv	59g	1ex	a	.641
	56.5	14°	0.14	iv	59g	1	a	.620
	134	11°	0.6	iv	211g	1	a	.602
$CaCl_2$	1.70	20°	0.7g Ag	iv	12g	1ex	a	.780
	2.07	12°	0.8	iv	12g	1	a	.771
	2.36	3°	0.7	iv	12g	1	a	.765
	2.74	10°	1.4	iv	12g	1	a	.749
	3.95	21°	1.0	iv	12g	1	a	.727
	21–229	20°	0.3	iv	32–58	2	a	.683
	138	9°	1.2	iv	215g	1	a	.673

CaI_2	1.32		0.8g Ag	iv	16g	1ex	a	.732
$Ca(NO_3)_2$	1.42	7°	0.7g Ag	iv	12g	1ex	a	.718
	3.96	7°	1.7	iv	12g	1	a	.652
	112	7°	0.9	iv	215g	1	a	.613
$MgCl_2$	2.48	6°	0.4g Ag	iv	11g	1ex	a	.806
	3.7	15°	1.2	iv	11–37	2	a	.778
	22.2	14°	0.8	iv	32g	1	a	.706
	128–241	6–15°	0.4	iv	58–213	2	a	.677
$Mg\ I_2$	0.796		1.1g Ag	iv	16g	1ex	a	.777
$MgSO_4$	5.28	4°	1.4g Ag	iv	10g	1ex	a	.762
	209	5°	0.5	iv	212g	1	a	.656
$MnCl_2$	3.31	7°	1.4g Ag	iv	11g	1ex	a	.758
	190	9°	0.5	iv	213g	1	a	.682
$ZnSO_4$	2.52		0.7g Ag	iv	16g	1ex	a	.778
	4.05		1.0	iv	14g	1	a	.760
	267		0.3	iv	220g	1	a	.636
$FeCl_3$	2.07		1.3g Ag	vii	14g	1ex	c	.746
	25.2		0.2	vii	20g	1	c	.600
$AlCl_3$	22.7		0.4g Ag	iv	12g	1ex	a	.714
UO_2Cl_2	10.4		0.4g Ag	iv	26g	1ex	a	.868
Morphine H.Cl	54.9		0.3g Ag	iv	92g	1ex	a	.815
Strychnine H.Cl	55.7		0.5g Ag	iv	93g	1ex	a	.861
HCl	2.91		1.3g Ag	iv	13g	1ex	a	.319
	9.86	7°	1.3	iv	9g	1	a	.193
	36.2	8°	0.4	iv	9g	1	a	.168
	82.3	8°	0.5	iv	56g	1	a	.161
	141		1.4	iv	220g	1	a	.171
	321	8°	0.3	iv	212g	1	a	.216
	2126	6°	0.3	iv	214g	1	a	.210
$SnCl_4$[1]	13.5		0.4g Ag	vii	12g	1ex	c	.180
HBr	8.65		0.7g Ag	iv	10g	1ex	a	.178
HI	4.82		0.7g Ag	iv	13g	1ex	a	.201
	117		0.4	iv	88g	1	a	.258
H_2SO_4	0.557		1.7g Ag	v	19g	1ex	a	.40c Pt anode
	1.438		2.6	v	15g	1	a	.288 " "
	5.42		1.3	iv	10g	1	a	.174 Cd "
	23.3		0.9	iv	58g	1	a	.177 " "
	98		0.6	iv	172g	1	a	.212 " "
	161		0.4	iv	174g	1	a	.206 " "
HIO^3	13.3		0.2g Ag	vi	25g	1ex	a	.102 Ag "
$Na_4P_2O_7$	35.6		0.4g Ag	vi	22g	1ex	a	.645 " "
Na_3PO_4	26–19		0.4–0.6	vi	23g	2ex	a	—[2] " "
$Na.PO_3$	10.6		0.5g Ag	iv	13g	1ex	a	.573

[1] Regarded by Hittorf as 1 part HCl in 24.3 parts water.

[2] Current carried mostly by alkali resulting from hydrolysis.

$K_4.Fe(CN)_6$	5.30		0.6g Ag	vii	23g	1ex	a	.482	
$K.Ag(CN)_2$	7.71		0.5g Ag	vii	21g	1ex	c	.406	
$Na_2.PtCl_6$	1.87		0.6g Ag	vii	14g	1ex	c	.562	
	13.1		0.4	vii	22g	1	c	.519	
$KCl.AuCl_3$	6.08		0.3g Ag	vii	12g	1ex	c	——	
	35.9		0.2	vii	21g	1	c	——	
$KCl.HgCl_2$	7.37		0.5g Ag	vii	24g	1ex	c	——	
$KCl.2HgCl_2$	8.19		0.3g Ag	vii	23g	1ex	c	——	
$KCl.4HgCl_2$	9.59		0.2g Ag	vii	23g	1ex	c	——	
$K.CdI_3$	0.327		1.0g Ag	vii	25g	1ex	c	.43–	
$KCd.I_3$	2.30		0.6	ii	12g	1ex	a	.79–[1]	
	58.7		0.3	ii	87g	1	a	.560	
$K.(C_2H_5)SO_4$	6.55		0.3g Ag	iv	9g	1ex	a	.302	
$Na_2.HPO_4$	20–31		0.6g Ag	vi	22g	1ex	a	.516	
$K.H_2PO_4$	7.59		1.0g Ag	vi	25g	1ex	a	.277	
	10.3		0.7	vi	25g	1	a	.266	
$Na.H_2PO_4$	5.71		0.9g Ag	vi	26g	1ex	a	.383	
CdI_2	1.83		0.3g Ag	ii	18g	1ex	a	1.258	
	3.04	11°	0.7	ii	16g	1	a	1.192	
	4.28	12°	0.7	ii	16g	1	a	1.14–	
	18.1	11°	0.4	ii	14g	1	a	.931	
	69.6		0.2	ii	222g	1	a	.642	
	167	10°	0.3	ii	220g	1	a	.613	
ZnI_2	0.664		2.0g Ag	ii	23g	1ex	a	1.157	Zn anode
	2.457		2.1	ii	16g	1	a	.727	" "
	112.9		0.4	ii	220g	1	a	.675	" "
$ZnCl_2$	2.77		1.8g Ag	ii	16g	1ex	a	1.08—	" "
	333		0.4	ii	219g	1	a	.700	" "
$CdCl_2$	1.27	7–11°	0.8g Ag	ii	17g	3ex	a	1.015	
	1.98	7°	1.7	ii	14g	1	a	.873	
	2.76	10°	1.1	ii	17g	1	a	.779	
	3.36	10°	0.5	ii	13g	1	a	.772	
	5.76		1.0	ii	12g	1	a	.744	
	98.7	8°	0.6	ii	220g	1	a	.725	
	192	11°	0.5	ii	222g	1	a	.708	
CdI_2	1.107		0.2g Ag	ii	16g	1ex	a	2.102	Ethyl alcohol
	1.394		0.3	ii	15g	1	a	2.001	" "
	1.695		0.4	ii	14g	1	a	1.909	" "
	2.190		0.4	ii	25g	1	a	1.848	" "
	2.466		0.3	ii	32g	1	a	1.827	" "
	2.466		0.3	ii	33g	1	a	1.819	" "
	8.375		0.3	ii	11g	1	a	1.552	" "
	37.23		0.1	ii	29g	1	a	1.318	" "

[1] For interpretation and recalculation of these results see J. W. McBain—Zeit. f. Elektrochem., *11*, 215. 1905.

ZnI_2	0.520	0.7g Ag	ii?	21g	1ex	a2.161	Zn	an.	Ethyl alc.
	0.707	0.9	ii?	19g	1	a2.008	"		"
	1.533	0.8	ii?	15g	1	a1.711	"		"
	1.534	0.6	ii?	15g	1	a1.705	"		"
	4.933	0.2	ii?	11g	1	a1.254	"		"
	16.14	0.2	ii?	30g	1	a .747	"		"
$ZnCl_2$	1.74	0.9g Ag	ii?	13g	1ex	a1.998	"		"
	6.79	0.5	ii?	10g	1	a1.538	"		"
CdI_2	3.179	0.1g Ag	ii?	11g	1ex	a2.3—	Amyl alcohol		

1868. **E. Bourgoin.**

Du role de l'eau dans l'electrolyse. Ann. Chim. Phys. (4), *15*, 47.

Apparatus: capacity 40 c.c.

I have deduced the following migration values from the experimental data afforded by the work of the author; the calculation is based (incorrectly) upon the change in constant volume of solution, not upon a constant weight of solvent.

KOH	1.68m	1ex	ac.746
	1.14	1ex	ac.749
H_2SO_4	0.2–0.5m	3ex	ac.168
HNO_3	1.66m	1ex	a .126

1868. **E. Bourgoin.**

De l'electrolyse des acides organiques et de leurs sels. Ann. Chim. Phys. (4), *14*, 157.

In this extended investigation carried out from another standpoint, in no case are sufficient data afforded to permit of the deduction of migration values, unless possibly in the case of succinic acid (n .6– – or .3– – ?).

1870. **E. Bourgoin.**

Mémoire sur l'inegalité des pertes d'acide et de sel dans le voisinage des pôles. Ann. phys. Chim. (4), *21*, 264.

The author rejects Hittorf's explanation of the changes of concentration during electrolysis in favor of that of d'Almeida; and classifies the acids according as the acidity at the anode increases or decreases by electrolysis.

The details of two experiments with oxalic acid are given. In the first, the loss of acid at the cathode was one third of that corresponding to the hydrogen collected from that electrode. In the second, the loss of acid was three times as great at the cathode as at the anode.

1878. **M. Kirmis.**

Zur Wanderung der Ionen. Wied. Ann., *4*, 503.

For apparatus see Wiedemann, 1856; capacity 110 c.c.; no diaphragms. The siphon became considerably heated. No middle portion; anode Cu, and cathode Pt.

The calculation is incorrect (based on constant volume of solution, not constant amount of water).

$CuSO_4$	5.06	percent	15°	4.5g Ag	3ex	c.723	
	4.83	"	4°	2.7	3ex	c.713	
	3.52	"	22°	5.9	3ex	c.702	
	3.17	"	13°	4.8	3ex	c.690	
	2.20	"	24°	2.0	3ex	c.686	
	1.75	"	23°	2.1	3ex	c.685	
	1.04	"	22°	3.5	3ex	c.655	
	0.497	"	9°	1.5	3ex	c.641	
	1–5	"	0–8°	—	4ex	c.780	Pt anode

1881. **J. Kuschel.**

Die Bestimmung der Ueberführungszahlen der Ionen für Lithium- und Kohlensäureverbindungen. Wied. Ann., *13*, 289; Dissert. Breslau.

Apparatus: (i) superposed glasses; diaphragms of gold-beaters' skin. The Pt cathode was surrounded by free acid, the anode was of Cd; the middle portion was tested for free acid and for Cd. (ii) a U-shaped cathode tube with three superposed glasses; capacity 25–60 c.c.; Pt electrodes. In the experiments with the carbonates the middle portion was tested for neutrality by litmus after precipitation by barium chloride. For the experiments with the caustic alkalis, porous earthenware was substituted for the diaphragms of gold-beaters' skin.

The method of calculation is correct.

KCl	13–0.23%		—g Ag	i	4ex	.518
LiCl	6.89m	18°	0.4g Ag	i	1ex	a.773
	3.21	21°	0.5	i	2	a.753 ± 2
	1.78	19°	0.4	i	2	a.738 ± 9
	0.809	17°	0.4	i	4	a.739 ± 7
	0.235	15°	0.2	i	2	a.718 ± 8
	0.118	14°	0.5	i	1	a.694
	0.103	13°	0.4	i	1	a.705
	0.046	16°	0.4	i	1	a.670
	0.039	17°	0.3	i	1	a.679
LiI	3.12m	17°	0.2	i	1ex	a.719
	1.41	20°	0.2	i	2	a.712 ± 4

	0.67	17°	0.2	i	2	a.727 ± 17
	0.66	19°	0.2	i	1	a.700
	0.33	19°	0.2	i	2	a.706 ± 1
	0.074	16°	0.2	i	3	a.692 ± 9
	0.037	14°	0.14	i	3	a.702 ± 9
	0.014	14°	0.1	i	2	a.682 ± 2
K_2CO_3	8.112m	26°	0.5g Ag	ii	2ex	c.341 ± 0
	3.15	23°	0.8	ii	2	c.404 ± 1
	1.61	22°	0.5	ii	2	c.416 ± 0
	0.764	22°	0.3	ii	2	c.437 ± 7
	0.441	24°	0.2	ii	1	c.434
	0.151	21°	0.2	ii	2	c.377 ± 3
	0.074	24°	0.14	ii	2	c.372 ± 4
	0.029	24°	0.07	ii	2	c.302 ± 7
Na_2CO_3	2.84m	23°	0.4g Ag	ii	2ex	c.530 ± 1
	0.985	23°	0.4	ii	2	c.548 ± 0
	0.189	24°	0.2	ii	2	c.519 ± 0
	0.093	24°	0.1	ii	2	c.474 ± 7
Li_2CO_3	0.232m	25°	0.2g Ag	ii	2ex	c.582 ± 5
	0.136	21°	0.2	ii	2	c.593 ± 9
Li_2SO_4	0.159m	23°	0.2g Ag	ii	2ex	c.649 ± 4
	0.090	22°	0.1	ii	2	c.595 ± 3
KOH	0.804m	23°	0.6g Ag	ii	2ex	c.739 ± 8
	0.190	27°	0.3	ii	2	c.730 ± 0
	0.103	22°	0.2	ii	2	c.742 ± 10
NaOH	1.084m	25°	0.6g Ag	ii	2ex	c.827 ± 4
	0.285	23°	0.3	ii	2	c.800 ± 5
	0.108	21°	0.1	ii	2	c.843 ± 4
LiOH	1.495m	25°	0.4g Ag	ii	1ex	c.890
	0.402	21°	0.4	ii	2	c.863 ± 3
	0.201	21°	0.4	ii	2	c.848 ± 9

1882. R. Lenz.

Ueber das galvanische Leitungsvermögen alkoholischer Lösungen. Beiblätter, 7, 399, from Mém. de St. Pétersb. (7), *30*, 64.

The transference of the iodine in aqueous and alcoholic solutions of CdI_2 and of KI was determined in an apparatus consisting of an H-tube fitting on top of an anode vessel. The contents of the latter were analyzed, The following table contains the values of n for iodine obtained by the author by interpolation from his experiments. The percent of alcohol in the solutions is given at the head of the column, the concentration of the CdI_2 in the first column.

The method of calculation is based (wrongly) on constant volume of solution.

	0	5	10	15	20	25	30
1m	1.135	1.110	1.089	1.073	1.072	1.077	1.088
½m	1.044	1.021	1.017	1.022	1.032	1.044	1.057
¼m	0.929	0.914	0.915	0.922	0.934	0.952	0.974
⅛m	0.808	0.818	0.831	0.851	0.876	0.899	0.928
	35	40	45	50	55	60	65
1m	1.108	1.130	1.160	1.193	1.226	1.262	1.300
½m	1.070	1.088	1.120	1.159	1.192	1.229	1.265
¼m	1.000	1.028	1.058	1.089	1.121	1.160	1.198
⅛m	0.959	0.989	1.019	1.052	1.088	1.127	1.170
	70	75	80	85	90	95	
1m	1.338	1.378	1.417	1.460	1.502	1.549	
½m	1.305	1.344	1.384	1.427	1.471	1.515	
¼m	1.239	1.282	1.329	1.375	1.421	1.470	
⅛m	1.212	1.262	1.306	1.357	1.404	1.458	

With solutions of potassium iodide the values $n = .511$ to $n = .520$ were found independent of the concentration and of the amount of alcohol present.

The experiments with potassium chromate were carried out in a slightly modified apparatus, in which a Pt cathode surrounded by potassium carbonate solution, and a Mg anode were employed; $n = .46 -$ to $n = .51 -$ independent of the concentration and of the percent of alcohol.

The paper further contains a number of measurements of conductivity and diffusion.

1885. **J. Moser.**

Elektrische und thermische Eigenschaften von Salzlösungen. Wien. Sitzungsber., *92*, Abth. II, 652.

The author calculated the migration values by means of the formulæ of Helmholtz from the E.M.F. of concentration cells with and without diffusion.

$ZnCl_2 + 100\ H_2O$ and $ZnCl_2 + 750\ H_2O$ 1ex .71—
$ZnSO_4 + 100\ H_2O$ and $ZnSO_4 + 800\ H_2O$ 1ex .64—

1886. **O. Lodge.**

On the Migration of Ions and an Experimental Determination of Absolute Ionic Velocity. Brit. Assoc. Rep., 1886, 389.

In the following series of experiments, two cups were connected by a horizontal siphon. When the current was passed through, the ions from the cups moved through the siphon, their progress being followed by a color change or by the formation of a precipitate.

Cups.		*Siphon.*		
$BaCl_2$, Na_2SO_4	10%	6% HCl, litmus	23ex	$Ba/SO_4 = \frac{3}{1}$
$BaCl_2$, Na_2SO_4	5%	6% HCl, litmus	14ex	$Ba/SO_4 = \frac{3}{1}$
$BaCl_2$, Na_2SO_4	5%	$C_2H_4O_2$, agar agar	9ex	$Ba/SO_4 = \frac{1}{1}$
$BaCl_2$, NaCl		$C_2H_4O_2$, H_2SO_4, $AgNO_3$, agar agar	4ex	$Ba/Cl = \frac{1}{2}$
$BaCl_2$, KI		$C_2H_4O_2$, H_2SO_4, $AgNO_3$, agar agar	5ex	$Ba/I = \frac{1}{2}$
$BaCl_2$, KBr	10%	$C_2H_4O_2$, H_2SO_4, $AgNO_3$, agar agar	3ex	$Ba/Br = \frac{1}{2}$
$SrCl_2$, NaCl	10%	$C_2H_4O_2$, H_2SO_4, $AgNO_3$, agar agar	2ex	$Sr/Cl = \frac{5}{6}$
$SrCl_2$, KBr	10%	$C_2H_4O_2$, H_2SO_4, $AgNO_3$, agar agar	2ex	$Sr/Br = \frac{5}{8}$
$SrCl_2$, KI	10%	$C_2H_4O_2$, H_2SO_4, $AgNO_3$, agar agar	2ex	$Sr/I = \frac{5}{8}$
$CuSO_4$, H_2SO_4		NaCl, $BaCl_2$, NaOH, phenol phthalein	3ex	$H^1/SO_4 = \frac{3}{1}$
$CuSO_4$, $CuSO_4$		NaCl, K_4FeCy_6	1ex	
$CuSO_4$, NaOH		NaCl, phenol phthalein	1ex	[2]
$(NH_4)_2SO_4$, —		NaCl, Nessler solution	1ex	

1888. M. Loeb and W. Nernst.

Zur Kinetik der in Lösung befindlichen Körper. Zeit. phys. Chem., *2*, 948.

Apparatus similar to Gay-Lussac's burette, with side tube at top for cathode; anode at bottom; capacity 60 c.c.; Ag electrodes. In preliminary experiments with silver nitrate the loss in the whole apparatus was 0.06 percent, the loss in the middle portions was 0.5–0.7 percent; no diaphragms; method of calculation correct.

The paper further contains a number of conductivity measurements in confirmation of Kohlrausch's law.

$AgNO_3$	0.1043m	20°	0.08g Ag	1ex	ac.528
	0.0521	26°	0.08	1	ac.524
	0.025	26°	0.05	1	ac.522
	0.025	0°	0.05	1	ac.538
	0.0105	26°	0.03	2	ac.522 ± 2
$AgClO_3$	0 0245m	25°	0.05g Ag	2ex	ac.501 ± 2
$AgClO_4$	0.0247m	25°	0.04g Ag	2ex	ac.513 ± 2
$Ag(C_2H_5)SO_4$	0.0243m	25°	0.05g Ag	2ex	ac.387 ± 2
	0.0061	25°	0.02	1	ac.384
$C_{10}H_7.SO_3.Ag$	0.0129m	29°	0.03g Ag	1ex	ac.390
	0.0250	25°	0.04	1	ac.386
$C_6H_5.SO_3.Ag$	0.0250m	25°	0.04g Ag	2ex	ac.347 ± 4
$C_2H_3O_2Ag$	0.0097m	25°	0.02g Ag	2ex	ac.376 ± 1
Ag_2SiFl_6	0.0282m	22°	0.05g Ag	2ex	ac.465 ± 2
$Ag_2S_2O_6$	0.0246m	25°	0.04g Ag	3ex	ac.605 ± 1
	0.0246	0°	0.05	2	ac.604 ± 1

[1] Absolute velocity of H ion = 0.0027.

[2] "OH nearly as quick as H."

$C_9H_{11}.SO_3.Ag$	0.0238m	24°	0.06g Ag	1ex	ac.293
	0.0222	29°	0.04	1	ac.295
	0.0222	0°	0.04	2	ac.273 ± 0

1889. C. L. Weber.

Ueber absolute Geschwindigkeit der Ionen. Zeit. phys. Chem., *4*, 182.

The author deduced the following migration values from measurements of the limiting current density at which normal products appear at the electrodes and above which secondary reactions occur. The third column below gives the velocities in mm. per second.

$CuSO_4$	$\frac{1}{2}$ of 80.16g Cu per litre	0.017
	$\frac{1}{4}$ of 80.16g Cu per litre	0.023
	$\frac{1}{8}$ of 80.16g Cu per litre	0.024
	$\frac{1}{16}$ of 80.16g Cu per litre	0.028
	$\frac{1}{32}$ of 80.16g Cu per litre	0.021
	$\frac{1}{64}$ of 80.16g Cu per litre	0.022
	$\frac{1}{128}$ of 80.16g Cu per litre	0.033
	$\frac{1}{256}$ of 80.16g Cu per litre	0.042
$CdSO_4$	0.1 m	0.023
	0.04	0.029
	0.02	0.026
	0.01	0.036
	0.005	0.045
	0.0025	0.051
$Zn(NO_3)_2$	0.2 m	0.091
	0.1	0.111
	0.04	0.095
	0.02	0.077
	0.01	0.084
	0.005	0.051
	0.0025	0.052
	0.0012	0.051

1890. A. Chassy.

Nouveau Transport Électrique. Ann. chim. phys. (6), *21*, 241.

The author determined the movement of one component of mixtures of salts in aqueous solution. Misled by assuming that the decomposition products at the electrodes indicated the salt that had carried the current, he had to explain the observed movement of the other salts present by the assumption of the movement of non-dissociated molecules. In the following list the first salt was in each case the only one measured. Many cases are omitted in which only one component of the mixture was indicated. For summary see Ponsot — Comptes rendus, *138*, 192.

Sulphates of Zn, Cu.
" " Zn, Cd.
" " Zn, Ag.
" " Zn, Na, Mg, Cu.
" " Zn, Cu, Ni, K.
Nitrates " Ba, Ag.
" " Ba, Cu.
" " Ba, Ni.
" " Ba, Zn.
" " Ba, K, Cu.
" " Ba, K, Cu, Na, Zn, Mg, Co, Ag.
" " Pb, Ba, Zn, K.
" " Cu, Ba, Ag, K.
Chlorides " K, Zn.
" " Ca, Na, Zn, Cu.
" " Zn, Ba, Mg, K.
Sulphates " K, Cd, Cu, with acetate of Zn.
K_2SO_4, $Zn(C_2H_3O_2)_2$.
$Zn(C_2H_3O_2)_2$, K_2SO_4, Na_2SO_4, $NaC_2H_3O_2$.

1890. W. Kistiakowsky.

Die wässerigen Lösungen von Doppelsalzen. Zeit. phys. Chem., *6*, 97.

Apparatus a knee-shaped burette; capacity 100 c.c.; Ag electrodes; no diaphragms; middle portion unchanged. The concentrations are expressed in mols per 1000g solution.

$AgNO_3$	0.0189	15°	0.04g Ag	1ex	ac.531
$Ag_3Cr(C_2O_4)_3$	0.022	14°	0.05g Ag	3ex	ac.57- ± 18

1892. W. Bein.

Beiträge zur experimentellen Bestimmung von Ueberführungszahlen in Salzlösungen. Wied. Ann., *46*, 29.

Apparatus of three types, capacity 55–90g, *viz.*; (i) superposed glasses with diaphragms of fish bladder (B), or usually of porous earthenware (E); (ii) a winding spiral and U-tube, no diaphragms; (iii) a knee-shaped burette.

In experiments with $CuSO_4$, $CdCl_2$, $CaCl_2$, and CdI_2 the voltage was varied from 20–100 volts without affecting the results. In the fifth column below are given the concentration changes in the middle portions; the values in the last column given in ( ) are those obtained by Bein in 1899 by a recalculation.

The method of calculation is correct; the accuracy of the better experiments is estimated to be one or two units in the second decimal place.

$CuSO_4$	0.73% Cu	20–30°	0.06g Cu	0.6–0.06%	i	E	6ex	a.647 ± 24
	0.73	16–19°	0.05	0.5–0.1	ii		2	ac.638 ± 2
	0.76	16–24°	0.06	0.4–0.03	i	B	8	a.79– ± 17
	0.76	74°	0.05	1.5	ii		1	ac.622
KCl	0.41% Cl	18–19°	0.06g Cl	0.1%	i	B	2ex	a.496 ± 3 (.530)
	0.6	74–75°	0.03	0.3	ii		2	ac.509 ± 9
$AgNO_3$	1.85% Ag	13–15°	0.06g Ag	0.5–0.05%	iii		3ex	ac.525 ± 3
	0.6	75–96°	0.06	2–0.4	iii		6	ac.512 ± 6
NaCl	0.92% Cl	7–8°	0.06g Cl	0.3%	ii		2ex	ac.608 ± 3
	0.92	95°	0.05	0.8–0.1	ii		3	ac.551 ± 2
$BaCl_2$	0.84% Cl	12°	0.07g Cl	1–0.3%	ii		2ex	ac.580 ± 2
	0.84	89°	0.07	0.5	ii		1	ac.565
	0.58	74°	0.05	0.6	ii		1	ac.580
CdI_2	0.68% I	20°	0.1g I	1–0.4%	i, ii	E	3ex	ac.65– ± 25 (.652)
	0.68	76°	0.06	1.5	ii		2ex	ac.600 ± 13
$CdCl_2$	0.9% Cl	8°	0.05g Cl	0.7%	ii		2ex	ac.567 ± 2
	0.6	21°	0.6	0.6–0.01	i	E	4	a.546 ± 20 (.557)
	0.87	96–97°	0.07	0.8–0.5	ii		2	ac.570 ± 5
$CaCl_2$	0.8% Cl	9°	0.05g Cl	1–0.1%	ii		2ex	ac.602 ± 2
	0.45	16°	0.08	0.3–0.04	i	B	6	a.610 ± 16 (.638)
	0.85	94°	0.04	0.2	ii		1	ac.549

1892. W. C. D. Whetham.

Ionic Velocities. Proc. Roy. Soc., *52*, 284. Zeit. phys. Chem., *11*, 220. Phil. Trans., *184*, A, 337.

The author measured the velocity of the meniscus between pairs of solutions of electrolytes, first with direct, and then with reversed current. The apparatus consisted of two vertical tubes joined by a third much narrower tube bent parallel to the others for the greater part of its length. Two solutions of equal specific resistance were placed in the apparatus, the specifically heavier below the other. The surface of contact lay in the narrow vertical tube, where the fall of potential per cm. could be determined.

In the following table, the salts experimented with are named in the first column, and in the succeeding columns in order are given the concentrations, the solvent (W = water, Am = aqueous ammonia, Al = "alcohol of 0.05 strength"), the ion to which the rate of the meniscus movement was ascribed, the number of experiments, the observed velocity in cm. per second per unit

potential fall, and the velocity calculated from Kohlrausch's conductivity measurements and Hittorf's migration determinations. In the case of the alcoholic solutions, for lack of migration determinations, the sum of the observed ionic velocities is compared with that calculated from the conductivity.

$CuCl_2$ and NH_4Cl	0.18m	Am	Cu	1ex	0.00026	0.00031
$CuCl_2$ and NH_4Cl	0.1	Am	Cl	1ex	0.000309	0.00031
KCl and $KMnO_4$	0.0046m	W	Cl	1ex	0.00057	0.00053
KCl and $KMnO_4$	0.046	W	Cl	1ex	0.00059	0.00053
$K_2Cr_2O_7$ and K_2CO_3	0.1m	W	Cr_2O_7	3ex	0.00047	0.00047
$K_2Cr_2O_7$ and KCl	0.1	W	Cr_2O_7	1ex	0.00044	0.00047
$Co(NO_3)_2$ and $CoCl_2$	0.05m	Al	Cl	2ex	0.000026	0.000060
$CoCl_2$ and $CaCl_2$	0.05m	Al	Co	2ex	0.000022	0.000060
			NO_3		0.000035	0.000079
$Co(NO_3)_2$ and $Ca(NO_3)_2$		Al	Co	1ex	0.000044	0.000079

1893. S. Lussana.

Einfluss der Temperatur auf die elektromotorische Kraft der Concentrationselemente und die Wanderung der Ionen. Beiblätter, *17*, 218, from Atti del R. Ist. Venet., Ser. VII, *3*, 1111 (1892).

Apparatus: Horizontal tube bent into five parallel portions, with vertical tubes sealed on at the ends and at the middle; 3 (?) middle portions.

The author found the migration of the cation $(1-n)$ proportional to the absolute temperature (T). In the second column below is given the weight of salt in 100g water; in the third the value found for $10^7(1-n)/T$; and in the last the transport of the anion at 0° C.

$ZnSO_47H_2O$	57.694–2.319	26632–25244	.27–.31
$CuSO_45H_2O$	5.008–0.712	24627–22076	.33–.40
$Pb(NO_3)_2$	26.512–4.618	18955–15982	.48–.53

1893. S. Sheldon and G. M. Downing.

Die kritische Stromdichtigkeit für Kupferniederschläge und die absolute Geschwindigkeit der Wanderung der Ionen. Beiblätter, *17*, 1090, from Phys. Rev., *1*, 51.

The author deduced the migration values from measurements of the limiting current density at which normal products appear at the electrodes, and above which secondary reactions occur. The velocity is presumably in cm. per second for unit potential fall.

$CuSO_4$	0.1–1.89m	0.00020–0.000445

1894. **A. Campetti.**

Ueber den Einfluss des Lösungsmittels auf die Geschwindigkeit der Ionen. Beiblätter, *18*, 942 (from Nuov. Cim. (3), *35*, 225).

LiCl	water	ac.705
	ethyl alcohol	ac.71–
	methyl alcohol	ac.64–
$AgNO_3$	water	ac.518
	ethyl alcohol	ac.51–
	methyl alcohol	ac.47–

1894. **S. Lussana.**

Einfluss von Magnetismus und Wärme auf die Wanderung der Ionen. Beiblätter, *18*, 364; (from Atti R. Ist. Veneto (7), *4*, 13 pp., 1893, Sepab.).

An extension of the author's work of the year before, with the same apparatus. In solutions of $NiSO_4$, NaCl, KCl, and $CuCl_2$ the relative velocity of the cation $(1-n)$ is proportional to the absolute temperature.

In order to ascertain whether magnetism exerts any noticeable influence on the transport, measurements were made of the rate of motion of the meniscus between acidified solutions of ferrous and cupric sulphates in and out of the magnetic field. The author finds that magnetism probably slightly reduces the rate of the ferrous ion; the resistance of ferrous sulphate solution is not noticeably affected by a magnetic field whose lines of force are perpendicular to the direction of the current.

1894. **W. C. D. Whetham.**

On the Velocities of the Ions and the Relative Ionization-power of Solvents. Phil. Mag., *38*, 392.

For apparatus, method and explanation of the following table, see Whetham, 1892. In these experiments the solutions were solidified with agar agar jelly. In the experiment with sodium acetate one half of the solution was colored red by caustic soda, the other half "decolorized by means of a few drops of dilute acetic acid." A measurement was made of the rate of motion of the red color at the boundary between solutions of ferric chloride and ferric acetate (containing ferric chloride); in order to explain his results the author ascribed the color to colloidal ferric hydrate, and adduced a number of conductivity measurements and experiments with dialyzed iron, in support of this view.

$K_2Cr_2O_7$ and K_2CO_3	0.1 m	W	Cr_2O_7	1ex	0.00044	0.00047
$NaC_2H_3O_2$	0.07m	W	H	1ex	0.000065	0.00030

1895. **W. C. D. Whetham.**

On the Velocities of the Ions. Phil. Trans., *186*, *A*, 507.

An extension of the author's work in 1892 and 1894. The same apparatus was employed. The solutions were solidified by the use of agar agar. The rate of extension of the precipitate formed at the surface of contact was measured; the current being passed in one direction only. The experiments were carried out at from 8–17° and corrected for 18°. The solutions were 0.1 m.

$BaCl_2$; and NaCl + "a little" Na_2SO_4	Ba	2ex	0.000389	0.000366
$CaCl_2$; and NaCl + "considerable" Na_2CO_3	Ca	1ex	0.000349	0.000290
$AgNO_3$; and $NaNO_3$ + "a little" NaCl	Ag	1ex	0.000488	0.000462
Na_2SO_4; and NaCl + $BaCl_2$	SO_4	2ex	0.000447	0.000492

1896. **C. Cattaneo.**

Ueber den Einfluss des Lösungsmittels auf die Geschwindigkeit der Ionen. Beiblätter, *21*, 749 (from Rendic. R. Acc. dei Lincei (5), *5*, 2 Sem. 207; *6*, 1 Sem. 279. Nuovo Cim. (4), *6*, 140.)

With sodium chloride and ammonium chloride a Pt cathode and a Zn or Cd anode was used; with hydrochloric acid the anode was of Au or Cu.

NaCl	water	.66–
	glycerine	.64–
NH_4Cl	water	.51–
	glycerine	.57–
HCl	water	.224
	ethyl alcohol	.205
	methyl alcohol	.236
	amyl alcohol	.240
	glycerine	.237
	ethyl alcohol with chloroform	.209
	ethyl alcohol with chloroform and ethyl ether	.218

1896. **Th. DesCoudres.**

Messungen der elektromotorischen Kraft Colley'schen Gravitationselemente. Wied. Ann., *57*, 232.

From measurements of the E.M.F. of gravitation cells with electrodes of Hg Hg_2Cl_2 the author deduced the following values for n.

NaCl	19.9 percent	.66-
$BaCl_2$	17.0 "	.64-
LiCl	17.3 "	.77-
KCl	16.8 "	.50-
HCl	3.56 "	.150
$CdCl_2$	30.1 "	1.02-1.10

1896. A. Rosenheim.

(Experiments by W. Bein.) Ueber die Einwirkung anorganischer Metallsäuren auf organische Säuren. Zeit. anorg. Chem., *11*, 175, 225.

Apparatus: two U-tubes connected by a siphon; capacity 108g; Pt electrodes; no diaphragms; no middle portion. The object of the investigation was to determine the constitution of these complex compounds. Concentration 1–2 percent; one experiment each; 18° C. In the last column is given the component analyzed. C_2O_3, Mo, W, and V moved in all cases toward the anode.

$(NH_4)_2O.2MO_3$	0.3g Ag	ac { .530 MO_3 / .539 NH_3
$MO_3.C_2O_3.3H_2O$	0.08g Ag	ac { .47- C_2O_3 / .48- MO_3
$K_2O.WO_3.C_2O_3.H_2O$	0.2g Ag	ac { .306 C_2O_3 / .327 WO_3 / .540 K
$(NH_4)_2O.2C_2O_3.2MO_3.3H_2O$	0.3g Ag	ac { .40- C_2O_3 / .40- MO_3
$(NH_4)_2O.2MO_3.C_2O_3$	0.2g Ag	ac .33- C_2O_3
$3(NH_4)_2O.V_2O_5.4C_2O_3.4H_2O$	0.02g Ag	ac { .36- C_2O_3 / .36- V_2O_5
"	0.1g Ag	ac .39- C_2O_3
$3K_2O.Al_2O_3.6C_2O_3.5H_2O$	0.4g Ag	ac .50- C_2O_3
$3K_2O.Cr_2O_3.6C_2O_3.6H_2O$	0.6g Ag	ac .33- C_2O_3
$K_2O.Al_2O_3.4C_2O_3.7\frac{1}{2}H_2O$	0.3g Ag	ac .39- C_2O_3

1897. V. Gordon.

Ueber die Abhängigkeit der Ueberführungszahlen des Kadmium in wässerigen Lösungen von der Temperatur. Zeit phys. Chem., *23*, 469.

Apparatus: N-tube fitting into the top of an Erlenmeyer flask; capacity 100 c.c.; anode Cd, cathode Hg; no diaphragms; method of calculation correct.

$CuSO_4$	9–10 percent		0.6g Ag	0.07 percent	2ex	a .720 ± 6
$CdSO_4$	11.4 "	9°	1–2g Ag	0.1 "	3ex	a .672 ± 10
	11.4 "	40°	1–2	0.1–0.2 "	2	a .717 ± 5
	12 "	81°	1.9	0.5 "	2	a .719 ± 4
	34.5 "	9°	1.9	0.2–0.5 "	2	a .803 ± 0

	34	percent	40°	3	0.1	percent	2	a .810 ± 6
	34	"	69°	3	0.2–0.6	"	2	a .797 ± 15
$CdBr_2$	29.5	"	7°	1 g Ag	0.2–0.01	"	3ex	a .894 ± 5
	29.4	"	39°	1.5	0.5–0.00	"	3	a1.040 ± 34
	29.4	"	75°	2.3	1–0.4	"	3	a .970 ± 25
CdI_2	35	"	40°	1.7g Ag	0.1–0.2	"	2ex	a1.232 ± 8
	35.5	"	74°	2.0	0.17	"	2	a1.231 ± 17

1897. F. W. Küster.

Ueber Ionenreaktionen und ihre Bedeutung für die Elektrochemie. Zeit. f. Elektrochem., *4*, 105.

When a current is passed through a U-tube whose lower half is filled with cupric sulphate solution, while both arms are filled with sodium sulphate solution into which the electrodes are dipped, then the blue layer moves toward the cathode; when the lower solution is Fehling's solution, and the upper Seignette salt, the blue color moves toward the anode, as the copper is contained for the most part in complex anions.

1897. W. J. Mather.

A New Apparatus for Determining the Relative Velocities of Ions; with some Results for Silver Ions. Johns Hopkins Univ. Cir., *16*, No. 130, 45 (1897), Am. Chem. Jour., *26* (1901), 473.

Apparatus: an M-shaped tube provided in the middle with a glass tap of large bore; capacity 90 c.c; Ag electrodes; no diaphragms; no middle portion; calculation based (incorrectly) on constant volume of solution.

$AgNO_3$	0.1 m	0°	0.1 g Ag	3ex	ac.541 ± 0	
	0.1	29°	0.05	1	ac.532	
	0.1	48°	0.15	3	ac.528 ± 1	
	0.025	0°	0.07	1	ac.538	
	0.025	45°	0.08	1	ac.525	
	0.1	24°	0.15	2	ac.532 ± 1	49 percent alcohol.
	0.108	20°	0.05	3	ac.594 ± 2	absolute alcohol.
$AgC_2H_3O_2$	0.025m	0°	0.05g Ag	2ex	ac.373 ± 1	
	0.025	28°	0.03	1	ac.382	
	0.025	46°	0.08	3	ac.389 ± 1	

1897. W. Nernst.

Zwei einfache elektrochemische Vorlesungsversuche. Zeit. f. Elektrochem. *3*, 308.

A 0.003m solution of potassium nitrate is placed in the arms of a U-tube over a solution of potassium permanganate of the

same specific conductivity, weighted with urea. During the passage of the current the red layer moves toward the anode with a velocity within a few percent of that calculated from the conductivity of potassium permanganate.

1897. **A. Schrader.**

Zur Elektrolyse von Gemischen. Zeit. f. Elektrochem., *3*, 498. Auszug aus Berliner Inaug. Dissert.

Apparatus: an ∞-tube; capacity 150 c.c; no diaphragms.

The paper is mainly devoted to the determination of the transport in aqueous solutions containing a pair of electrolytes, viz.: KCl and KI; H_2SO_4 and $CuSO_4$. In addition the following results of measurements with acetic acid between Ag electrodes are given without experimental details. "The rate of transport of acetic acid seems to become constant only at dilutions where the error of analysis is nearly as great as the quantity measured."

0.79m .362;	0.74m .307;	0.59m .241;
0.48m .212;	0.36m .182;	0.25m .169.

1898. **W. Bein.**

Zur Bestimmung der Ueberführung bei der Elektrolyse verdünnter wässeriger Salzlösungen. Zeit. phys. Chem., *27*, 1.

Apparatus of various forms, complete, and somewhat complicated; no diaphragms; Pt cathode, Cd anode; method of calculation correct.

The capacities of the apparatus are given in hektograms in the sixth column below, the percent changes in the middle portion in the fifth column.

	Percent.			Percent.			
HCl	0.02–0.05 Cl	9°	0.02g Cl	0.1	1–5	2ex	ac.167 ± 1
	0.035	50°	0.03		5	2	ac.199 ± 0
	0.035	96°	0.03		5	3	ac.252 ± 10
	0.2–0.5	16°	0.03	0.2–2	1	8	ac.170 ± 3
	0.2–0.5	77°	0.04	0	1	3	ac.219 ± 12
	13.9	97°	0.1		½	1	ac.393
NaCl	0.02–0.05 Cl	10°	0.02g Cl	0.0–0.3	7	5ex	ac.615 ± 12
	0.040	51°	0.03		5	2	ac.583 ± 5
	0.040	97°	0.03		1–5	2	ac.547 ± 4
	0.25	76°	0.03		1	1	ac.586
	0.2–0.9	12°	0.03	0.3–5	1	11	ac.613 ± 20
	0.50	76°	0.03	0	1	2	ac.570 ± 5

	0.2–0.9	95°	0.05		1	4	ac.557 ± 4
	12.1	21°	0.3		½	1	ac.677
	14.2	97°	0.14		½	1	ac.567
KCl	0.04–0.5 Cl	11°	0.02g Cl	0.04–4	1–7	5ex	ac.503 ± 20
	0.30	76°		0.6	1	3	ac.510 ± 2
NH_4Cl	0.2 Cl	20°	0.02g Cl	0.6	1	2ex	ac.507 ± 6
RbCl	0.19 Cl	22°	0.02g Cl		1	1ex	ac.515
CsCl	0.18 Cl	20°	0.02g Cl		1	1ex	ac.508
TlCl	0.04 Cl	21°	0.02g Cl		5	1ex	ac.516
LiCl	0.036 Cl	20°	0.03g Cl		5	2ex	ac.624 ± 4
	0.035	97°	0.02		5	2	ac.617 ± 6
	0.2–0.5	20°	0.03		1	6	ac.672 ± 9
	0.20	96°	0.03		1	2	ac.610 ± 9
$CaCl_2$	0.039 Cl	22°	0.03g Cl		1	1ex	ac.553
	0.039	49°	0.03		5	1	ac.555
	0.0391	97°	0.03		5	1	ac.530
	0.204	97°	0.03		1	1	ac.554
	0.425	97°	0.04		1	1	ac.574
	0.20	25°	0.03		1	3	ac.567 ± 40
	0.42	24°	0.04		1	1	ac.595
	0.99	21°	0.05		1	1	ac.610
	14.1	25°	0.26		½	1	ac.718
	14.1	97°	0.13		½	1	ac.79–
$BaCl_2$	0.040 Cl	10°	0.03g Cl		7	2ex	ac.559 ± 1
	0.041	50°	0.03		5	1	ac.525
	0.041	97°	0.03		5	1	ac.515
	0.30	10°	0.04		1	2	ac.570 ± 2
	0.6–1.0	12°	0.06		1	3	ac.585 ± 11
	0.77	96°	0.03		1	1	ac.543
	0.301	76°	0.03		1	2	ac.553 ± 3
	0.202	78°	0.02		1	1	ac.518
$CdCl_2$	0.036 Cl	20°	0.02		5	1ex	ac.557
	0.20	24°	0.02		1	2	ac.568 ± 3
	0.20	96°	0.03		1	2	ac.475 ± 2
	0.50	17°	0.03		1	2	ac.567 ± 11
	13.8	97°	0.12		½	2	ac.963 ± 3
	13.8	24°	0.19		½	1	ac.657
$AgC_2H_3O_2$	0.43 Ag	24°	0.08g Ag		1	1ex	ac.413Pt elec.
	0.43	24°	0.07		1	1	a.385[1] c.414Ag/Pt
	0.43	49°	0.07		1	1	c.412Ag/Pt
	0.43	96°			1	2	c.438 ± 4
$AgNO_3$	0.54 Ag	76°	0.04g Ag	0.2	1	1ex	ac.517
	0.40	96°	0.07		1	1	ac.482
H_2SO_4	0.24 H_2SO_4	11°	0.05g SO_4		1	3ex	ac.175 ± 3
	0.24	23°	0.05		1	1	c.200
	0.24	96°	0.05		1	2	ac.304 ± 1

[1] Superoxide formed at anode.

$CuSO_4$	0.032Cu	1°	0.03g Cu		6	1ex ac.615
	0.032	15°	0.02		6	1 ac.633
	0.30	0°	0.03		1	1 ac.611
	0.30	50°	0.04		1	1 ac.607
	0.73	15°	0.05		1	1 ac.632
	0.76	74°	0.05		1	1 ac.622
	0.30	97°			1	5 ac.21– to .47–
$SrCl_2$	0.04 Cl	21°	0.03g Cl		5	1ex ac.560
	0.20	20°	0.03g		1	1 ac.575
$MgCl_2$	0.17 Cl	21°	0.02g Cl		1	1ex ac.615
$MnCl_2$	0.20 Cl	18°	0.03g Cl	1.5	1	1ex ac.613
$CuCl_2$	0.18 Cl	23°	0.03g Cl		1	1ex ac.595
$CoCl_2$	0.20 Cl	18°	0.03g Cl	1	1	1ex c.596
	9.8	26°	0.16		½	2 ac.736 ± 0
	9.8	97°	0.13		½	2 ac.77– ± 2–
NaBr	0.39 Br	22°	0.05g Br		1	1ex ac.625
KI	0.63 I	25°	0.1 g I		1	1ex ac.505
HNO_3	0.32 HNO_3	25°	0.06g NO_3		1	1ex ac.172
$NaNO_3$	0.33 NO_3	19°	0.02g NO_3		1	1ex ac.629
Tl_2SO_4	0.25 SO_4	23°	0.03g SO_4		1	1ex ac.528
$MgSO_4$	0.24 SO_4	24°	0.05g SO_4		1	1ex ac.541
Na_2CO_3	0.16 CO_3	22°	0.014g CO_3		1	2ex ac.590 ± 10
K_2CO_3	0.13 CO_3	23°	0.014g CO_3		1	1ex ac.435 Pt/Pt.
NaOH	0.16 NaOH	25°	0.03g NaOH		1	1ex ac.799 "
NH_4OH	0.18 NH_4OH	21°	0.014g NH_4OH		1	1ex ac.562 "
$Ca(OH)_2$	0.11 $Ca(OH)_2$	24°	0.03g $Ca(OH)_2$		1	1ex ac.786 "
$KMnO_4$	0.85 $KMnO_4$	23°	0.1g$KMnO_4$		1	1ex ac.559 "
$H_2C_2O_4$	0.25 $H_2C_2O_4$	26°	0.04g $H_2C_2O_4$		1	1ex c.214 "
Succinic Acid	0.59 S.Ac.	23°	0.04g S.Ac.		1	1ex c.239 "

1898. H. Hoffmeister.

Ueber Stromleitung in gemischten Lösungen. Zeit. phys. Chem., *27*, 345.

Mixtures of from 1–9 parts of a solution of silver nitrate with 1–9 parts of a solution of nitric acid, and of 1–9 parts of sodium acetate with 1–9 parts of acetic acid, all four stock solutions being normal, were electrolyzed. The concentration changes for the cations of the nitrates were in accordance with that deduced by means of Rudolphi's dilution formula; for the sodium in the acetate mixture in accordance with Ostwald's dilution formula, while the acetic acid moved if at all toward the anode.

1898. K. Hopfgartner.

Ueber Stromleitung in gemischten Lösungen von Elektrolyten. Zeit. phys. Chem., *25*, 115.

For apparatus see Gordon, 1897; capacity 250 c.c. The Hg cathode was surrounded by a concentrated solution of $ZnCl_2$; for the electrolyses of sodium, hydrogen, and barium chlorides the anode was of Cd, for those with magnesium and cupric sulphates Cu was used. No diaphragms. The changes in the middle portions are listed in the fourth column below; 1g Ag in voltameter; method of calculation correct.

The paper also contains determinations of the transference in solutions of NaCl and HCl, $BaCl_2$ and HCl, $MgSO_4$ and $CuSO_4$, in widely different proportions, the concentrations varying from 0.1–1.0m per liter. The results are in accordance with those calculated from the conductivities of the salts taken separately, using Rudolphi's dilution formula.

NaCl	0.1m	16–17°	0.2–0.5 percent	3ex	a.617 ± 14
	0.2	13–19°	0.2–0.5 "	2	a.622 ± 1
	0.5	9–23°	0.2–0.5 "	3	a.623 ± 3
	0.8	13–19°	0.2–0.5 "	3	a.635 ± 2
	0.9	13–20°	0.2–0.5 "	3	a.635 ± 4
HCl	0.1m	15–18°	0.1–0.7 "	5ex	a.167 ± 20
	0.2	17–19°	0.0–0.5 "	4	a.164 ± 3
	0.5	13–26°	0.1–0.4 "	9	a.167 ± 18
	0.8	14–20°	0.1–0.3 "	6	a.157 ± 10
	0.9	13–20°	0.1 "	3	a.159 ± 10
$BaCl_2$	0.1m	14–18°	0.4–0.2 "	4ex	a.580 ± 13
	0.2	15°	0.4–0.2 "	2	a.592 ± 1
	0.5	11–15°	0.4–0.2 "	5	a.611 ± 16
	0.8	12–20°	0.4–0.2 "	5	a.617 ± 21
$MgSO_4$	1.0m	10–15°	0.4–0.2 "	3ex	a.749 ± 5
	1.3	10–13°	0.4–0.2 "	1	a.747
$CuSO_4$	1.0m	6–11°	0.1 "	3ex	a.696 ± 6
	0.7	8–15°	0.1 "	2	a.684 ± 7

1898. G. Kümmell.

Die Ueberführungszahlen von Zn- und Cd-Salzen in sehr verdünnten Lösungen. Wied. Ann., *64*, 655.

(i) The cathode vessel is attached to the top of the anode vessel by means of a side tube packed with cotton wool; capacity 175 c.c.; no change could be detected in the middle portion; Pt cathode; for Zn salts Zn anode, for Cd salts Cd anode; ap-

parently the incorrect method of calculation based on constant volume of solution was used.

$ZnCl_2$	0.01–0.003m	0.03g Zn	4ex	ac.603 ± 19
$ZnBr_2$	0.01–0.003m	0.02g Zn	3ex	ac.600 ± 12
ZnI_2	0.01–0.003m	0.02g Zn	3ex	ac.589 ± 12
$CdCl_2$	0.01–0.003m	0.05g Cd	3ex	ac.576 ± 8
$CdBr_4$	0.01–0.003m	0.05g Cd	3ex	ac.584 ± 9
CdI_2	0.01–0.003m	0.04g Cd	4ex	ac.552 ± 9
$ZnSO_4$	0.01–0.003m	0.03g Zn	4ex	ac.664 ± 7
$CdSO_4$	0.01–0.003m	0.04g Cd	4ex	ac.619 ± 15

(ii) By means of Helmholtz's formulæ, from the E.M.F. of concentration cells.

$ZnCl_2$	0.1–0.001m	4ex	.585 ± 3
$CdCl_2$	0.1–0.001m	4ex	.574 ± 10
$ZnSO_4$	0.025–0.001m	2ex	.587 ± 2
$CdSO_4$	0.025–0.001m	2ex	.627 ± 2

1898. D. McIntosh.

The Transference Number of Hydrogen. Jour. Phys. Chem., *2*, 273.

The transference number was obtained from the ratio of the E.M.F.'s of concentration cells with and without diffusion, making use of the formulæ of Helmholtz.

(i) Electrodes of hydrogen (platinised platinum), and mercury plus mercurous salt.

HCl	1.0–0.001m	6ex	.159 ± 3
HBr	"	6ex	.158 ± 6
HI	"	6ex	.161 ± 18
H_2SO_4	"	6ex	.174 ± 18
$H_2C_2O_4$	"	6ex	.163 ± 16

(ii) Electrodes of hydrogen and chlorine (platinised platinum).

HCl	1.0–0.1 m	1ex	.126
	1.0–0.01	1ex	.297
	0.1–0.01	1ex	.404

1898. O. Masson.

Ueber Ionengeschwindigkeiten. Zeit. phys. Chem., *29*, 501. Phil. Trans., 1899, *192*, 331.

Apparatus: two electrode chambers (flasks) connected by a narrow tube containing the gelatinized solution to be measured. "Indicators" were placed in the flasks (cupric sulphate or chloride at the anode, and potassium chromate at the cathode), and

the current passed until blue met yellow. Electrodes: Cu anode, Pt cathode; 18° C.

NH_4Cl	1.0m	18°	1ex	ac.499
KCl	0.5m		1ex	ac.495
	1.0		1ex	ac.490
	3		1ex	ac.483
NaCl	0.5m		1ex	ac.598
	1		1ex	ac.595
	2		1ex	ac.587
LiCl	0.5m		1ex	ac.687
	1		1ex	ac.680
K_2SO_4	0.5-1m		2ex	ac.467 ± 0
Na_2SO_4	1-0.5m		2ex	ac.567 ± 0
Li_2SO_4	2-0.5m		3ex	ac.658 ± 6
$MgSO_4$	2-0.5m		3ex	ac.693 ± 9

1898. R. Peters.

Ueber Oxydations und Reduktionsketten und den Einfluss komplexer Jonen auf ihre elektromotorische Kraft. Zeit. phys. Chem., *26*, 229.

Apparatus — a U-tube into both arms of which were dipped tubes closed at the lower end with parchment forming the anode and cathode compartments respectively, in the U-tube were plugs of cotton batting; Pt. electrodes; no middle portion.

The results are only qualitative, and show that in a solution of $FeFl_3.3NaFl + \frac{1}{2}H_2O$ containing 0.8 mg iron in 1 c.c. the iron moves toward the anode, presumably in the form of $FeFl_6'''$. In the case of an equivalent solution of $Fe_2(SO_4)_3$ under the same conditions the difference in titration value of a constant weight of solution before and after electrolysis was three times as great; here the iron moved towards the cathode.

1899. W. Bein.

Einige Versuche über die Abhängigkeit der Ueberführungen von Salzen von der Beschaffenheit der Membranen, welche die Elektroden-Lösungen voneinander trennen. Ein Beitrag zu dem Verhalten von Membranen gegen Salzlösungen. Zeit. phys. Chem., *28*, 439.

Apparatus: superposed glasses with diaphragms, viz.; earthenware (earth), fish bladder (fish b), parchment (parch), goldbeater's skin (gold). Capacity 200g; Pt electrodes in the experiments with CdCl. 20–22° C.

On page 447 of the paper is given a comparative table of

the results of Hittorf, Kuschel, Kirmis, and of the author, for the experiments in which diaphragms were used.

HCl	0.207 percent Cl	0.4 g Cl		earth	1ex	a.167
	0.207 " "	0.4		parch	1	a.176
	0.297 " "	0.4		fish b	1	a.29-
	0.208 " "	0.4		gold	1	c.29-
NaCl	0.20 " "	0.2 g Cl	0.05 percent	earth	2ex	ac.601 ± 1
	0.2-0.3 " "	0.3	2-3 "	fish	6	ac.718 ± 27
LiCl	0.27 " "	0.05g Cl	2-6 percent	gold	3ex	c.739 ± 17
$CaCl_2$	0.22 " "	0.03g Cl		earth	1ex	a.582
	0.22 " "	0.03		fish	4	a.733 ± 19
	0.22 " "	0.03		gold	2	a.805 ± 0
$CdCl_2$	0.20 " "	0.04g Cl	4 percent	fish	1ex	ac.763
	0.68 " "	0.06		earth	1	c.538

1899. W. Dittenberger und R. Dietz.

Ueber das elektrolytische Verhalten des Platin- und Zinnchlorids. Wied. Ann., *68*, 853.

Apparatus: (i) anode and cathode cylinders connected at the bottom by a tube of 0.5 mm. diameter bent seven times; (ii) and (iii) a similar tube bent three times (W-shaped). Capacity of (i) and (ii) 25–30g, of (iii) 300g; Pt electrodes; no diaphragms; no middle portion. The weight of Ag given below is calculated from the ampere-minutes. The solutions were analyzed only for Pt and Sn. The method of calculation is incorrect (constant volume of solution instead of constant amount of water). Although the conductivity greatly increases, the migration number is unaffected by setting the solution of $H_2.PtCl_4O$ in sunlight for 14 days.

$H_2.PtCl_4O$	0.50 m	0.002 g Ag	i	1ex	ac.137
	0.44	0.002	i	1	ac.132
	0.41	0.003	i	2	ac.125 ± 2
	0.36	0.003	i, ii	3	ac.125 ± 3
	0.10	0.0006	ii	2	ac.111 ± 2
	0.01	0.0006	iii	1	ac.077
	0.005	0.0003	iii	1	ac.075
$H_2.PtCl_6$	0.22 m	0.002 g Ag	i	1ex	ac.108
	0.007	0.0008	iii	1	ac.075
$SnCl_4$	6.6m	0.005 g Ag	i	1ex	ac.996
	1.2	0.002	i	2	ac.914 ± 13

1899. C. Dittrich.

Die Uranylsalze vom physikalisch-chemischen Standpunkt aus betrachtet. Zeit. phys. Chem., *29*, 481.

The solution to be investigated was placed in the bottom of a U-tube: above it in both branches was placed a solution of the pure acid, in some cases in tubes closed at the bottom with parchment, and containing Pt electrodes. When necessary the uranyl solution was made specifically heavier by the addition of urea. After the passage of the current the electrode solutions were examined for uranium. In the following table are given the components of the mixed solutions investigated, and the compartment into which the uranium migrated. All experiments were performed at least twice. In the cases of the pure uranyl salt solutions, the uranium was moved in all cases towards the cathode.

Na and UO_2 nitrates	cathode
" " " chlorides	"
" " " sulphates	"
" " " acetates (both concentrated)	anode
" " " " (" dilute)	cathode
" " " propionates	anode
" " " glycolates	cathode
" " " lactates	"
" " " oxalates	anode
" " " tartrates	"
" " " citrates	"
" " " salicylates	mostly cathode, partly anode.

1899. W. Hittorf und H. Salkowski.

Ueber eine merkwürdige Klasse unorganischer Säuren und ihr elektrolytisches Verhalten. Zeit. phys. Chem., *28*, 546.

Apparatus: two glass trays connected by a siphon, the cathode in a glass bell suspended above; capacity 25 c.c; Pt electrodes; no diaphragms; no middle portion; calculation correct.

$PtCl_4O.H_2$	7 percent	0.4g Ag	1ex	c.146
	2 "	0.1	1	c.126
$AuCl_3O.H_2$	24 percent	0.8g Ag	1ex	c.232
	12 "	0.5	1	c.233
	2 "	0.14	1	c.227

1899. O. Masson and B. D. Steele.

The Blue Salt of Fehling's Solution and other Cuprotartrates. Jour. Chem. Soc., *75*, 725.

Two flasks containing Pt electrodes surrounded by a neutral Fehling's solution, prepared by saturating a potassium hydroxide solution with cupric tartrate, were connected by a horizontal tube filled with a normal solution of sodium chloride solidified by gelatine. A blue color (complex anion) moved into the tube from the cathode but not from the anode side. In a second experiment where the anode vessel was filled with cupric sulphate solution, a dark blue color moved as before up the tube from the cathode flask, and a light blue (cupric chloride) from the anode end; before the latter met the dark blue its boundary was precipitated, showing that it had met a colorless anion (probably tartrate) which traveled faster than the complex copper-containing anion.

1899. M. Mugdan.

Zeit. f. Elektrochemie, *6*, 309 (see A. Kendrick, 1900).

1899. W. Starck.

Neue Beiträge zur Kenntnis der Ionen verdünnter Schwefelsaure. Zeit. phys. Chem., *29*, 385. Auszug aus einer Greifswalder Dissert.

Apparatus: (i) superposed glasses with parchment or earthenware diaphragms. (ii) three U-tubes connected by two siphons; no diaphragms; capacity 30–40 c.c. Middle portions unchanged; Pt electrodes; method of calculation correct. "Diaphragms hold the cation"; Cf. Bein, "hold anions."

H_2SO_4	0.30 percent	17-20°	0.2g Ag	i	1ex	a.135
	0.5–0.6 "	17-20°	0.3	i	5	a.145 ± 7
	2.6 "	17-20°	0.9	i	1	a.163
	5.2 "	17-20°	1.1	i	1	a.175
	10–18 "	17-20°	1.1	i	7	a.195 ± 13
	30.4 "	27-20°	1.1	i	4	a.215 ± 8
	0.59 "	31°	0.4	ii	1	ac.204
	5.5 "	16°	0.6	ii	1	ac.198
	5.5 "	7°	0.6	ii	1	ac.191
	39.6 "	5°	1.1	ii	2	ac.218 ± 3
	42.0 "	35–37°	0.9	ii	4	ac.277 ± 10
	50.5 "	36°	0.9	ii	1	ac.450
	62.0 "	15°	0.7	ii	1	ac.497
	70.2 "	29°	0.9	ii	1	ac.569
	70.1 "	47°	0.8	ii	1	ac.709
	81.0 "	16°	0.8	ii	2	ac.644 ± 4

1900. K. Hellwig.

Ueber einige komplexe Silbersalze. Zeit. anorg. Chem., *25*, 157.

Apparatus U-shaped, consisting of two vertical tubes connected underneath by a narrow tube with a glass tap in the middle: Ag electrodes surrounded with cotton. The author showed by qualitative experiments that AgI moves toward the cathode, probably as component of a complex cation, in solutions of $Ag_3I(NO_3)_2$ containing from 0.2g AgI in 10 c.c. up to saturation (the latter at 70° C.).

1900. A. Kendrick.

Ueberführungszahl von Schwefelsäuregemischen aus Messungen am Bleiakkumulator. Zeit. f. Elektrochemie, *7*, 52.

The author measured the E.M.F.'s of three types of concentration cell; in each, electrodes of the same material were immersed in two solutions of sulphuric acid, which were connected by a siphon; the three kinds of electrodes used were Pb, H_2 and PbO_2. The migration value was calculated from the formulæ for the E.M.F.'s of each two sorts; the headings of the columns below indicate which two were used as the basis of calculation.

		H_2 and PbO	H_2 and Pb.
H_2SO_4	1.8 percent	.147	.189
	2.5 "	.213	.218
	4.0 "	.188	.228
	5.0 "	.178	.207
	7.5 "	.164	.188
	10.0 "	.156	.181
	12.5 "	.131	.158
	15.0 "	.140	.162
	17.5 "	.131	.168
	20.0 "	.132	.177
	22.5 "	.133	.177
	25.0 "	.144	.197
	27.5 "	.187	
	30.0 "	.217	
	32.5 "	.263	
	35.0 "	.284	
	37.5 "	.296	
	40.0 "	.327	
	42.5 "	.349	
	45.0 "	.351	
	47.5 "	.359	
	50.0 "	.396	
	52.5 "	.420	
	55.0 "	.456	

The values calculated from Pb and PbO_2 electrode cells are supplemented by corresponding values calculated from the measurements of Mugdan (1899, Zeit. f. Electrochemie, *6*, 316) which are given in the third column below.

	Pb and PbO_2.	Mugdan.
1.4 percent	.180	.300
2.7 "	.200	.290
5.3 "	.100	.258
10.2 "	.144	.245
19.4 "	.216	.282

1901. **H. T. Calvert.**

Ueber die Alkalisalze des Hydroperoxyds in wässriger Lösung. Zeit. phys. Chem., *38*, 535. Zeit. f. Elektrochem., *7*, 624.

In the bottom of a U-tube was placed the solidified solution obtained by diluting a saturated potassium nitrate solution sevenfold with 2 percent agar agar solution and adding 8 percent (volume) of a normal sodium hydroxide solution which had been saturated with lead oxide. Above this on both sides of the U-tube was placed a layer 1 cm. deep of the same solution without the addition of plumbite. The rest of the tube was filled with a solution $\frac{1}{4}$ m. in respect to NaOH, 1.0 m. in respect to H_2O_2. The specific conductivity was the same throughout the tube, the temperature was 0° C. On passing a current through, a brown ring of lead superoxide was formed in the *lower* agar agar solution at the boundary on the cathode side, and another in the aqueous solution at the boundary on the anode side. Reversing the current reversed the phenomena. Although the author does not discuss the possibility of cataphoresis the resultant difference of 2 cm. in hydrostatic level on the two sides (which would be necessary to explain the results on this supposition) could not escape observation, and thus the experiment demonstrates the migration of a peroxide ion.

1901. **R. Gans.**

Ueber die Abhängigkeit der elektrolytischen Ueberführung und der elektromotorischen Kraft reversibler Elemente von physikalischen Einflüssen. Drude's Ann., *6*, 315.

From his measurements of the E.M.F. of the concentration cell $Zn/0.4$ m. $ZnSO_4/0.04$ m. $ZnSO_4/Zn$ the author deduces the formula $n = 0.699\ (1 + 0.00012\ p)$ to represent the effect of

pressure upon the migration value, which he assumes as 0.699; p is the pressure in atmospheres.

1901. H. Jahn's Schüler.

Ueber die Wanderungsgeschwindigkeit der Ionen in verdünnten Lösungen. Zeit. phys. Chem., *37*, 673; *38*, 127.

Apparatus: N-shaped tube fitting on top of the Erlenmeyer-flask-like anode compartment; capacity of the anode vessel 300–700 c.c.; no diaphragms; Hg cathode surrounded by a concentrated solution of copper nitrate or cadmium sulphate; 18°–19°; calculation correct.

In the fourth column I have calculated the percent change in the middle portion.

			Percent.			
Bogdan.						
HCl	0.031–0.0091m	0.4g Ag	0.1	17ex	a .174 ± 6	Zn anode
Bukschnewski.						
HNO_3	0.25–0.0066m	0.2–4g Ag	0.1–0.01	23ex	a .170 ± 4	Ag "
Bogdan.						
KCl	0.03–0.008m	0.4g Ag	0.1	11ex	a .503 ± 2	Zn "
NaCl	0.03–0.008m	0.4g Ag	0.03–0.1	12ex	a .604 ± 2	" "
KBr	0.03–0.01m	0.4g Ag	0.03	9ex	a .504 ± 2	" "
	0.069–0.034	0.5	0.1	6	a .500 ± 2	" " [1]
	0.017–0.011	0.2	0.13	4	a .495 ± 3	" " [1]
	0.066	0.3	0.07	3	a .494 ± 2	" " [2]
	0.3	0.3	0.2	3	a .503 ± 2	" " [2]
NaBr	0.015–0.006m	0.2g Ag	0.2–0.02	6ex	a .604 ± 3	" "
Oppenheimer.						
NaBr	0.032–0.006m	0.4g Ag	0.06–0.01	15ex	a .606 ± 2	" "
Goldhaber.						
LiCl	0.253m	0.7g Ag	0.1	3ex	a .700 ± 2	" "
	0.125	0.8	0.1	3	a .688 ± 3	" "
	0.0624	0.5	0.1	3	a .684 ± 2	" "
	0.03–0.008	0.4	0.1–0.01	18	a .669 ± 5	" "
Berliner.						
$AgNO_3$	0.03–0.005m	0.3g Ag	0.1–0.03	13ex	a .530 ± 5	" "
Bukschnewski.						
$BaCl_2$	0.016m	0.5g Ag	0.1–0.01	3ex	a .543 ± 1	" "
	0.008	0.4	0.1–0.03	3	a .548 ± 2	" "
	0.0056–0.0029	0.3	0.1–0.01	9	a .553 ± 2	" "

[1] 25 percent ethyl alcohol.

[2] 50 percent ethyl alcohol.

Goldhaber.						
$CdCl_2$	0.06–0.008m	0.8g Ag	0.4–0.01	23ex	a .570 ± 3	Cd anode
Bukschnewski.						
$CdCl_2$	0.006–0.0032m	0.3g Ag	0.07–0.01	9ex	a .570 ± 2	" "
Goldhaber.						
$CdBr_2$	0.502m	1.2g Ag	0.1	3ex	a .782 ± 2	" "
	0.251	0.8	0.1	3	a .650 ± 3	" "
	0.125	0.7	0.1	3	a .601 ± 2	" "
	0.083	0.8	0.1	3	a .577 ± 2	" "
	0.06–0.01	0.4	0.3–0.01	21	a .569 ± 4	" "
Bukschnewski.						
$CdBr_2$	0.008–0.0033m	0.3g Ag	0.1–0.01	12ex	a .571 ± 4	" "
Redlich.						
CdI_2	0.249m	1 g Ag	0.2–0.0	3ex	a1.003 ± 16	" "
	0.125	1 g Ag	0.2–0.0	3	a .925 ± 9	" "
	0.0805	1 g Ag	0.2–0.0	2	a .777 ± 12	" "
	0.0623	1 g Ag	0.2–0.0	3	a .719 ± 7	" "
	0.0409	1 g Ag	0.2–0.0	2	a .657 ± 1	" "
	0.0311	1 g Ag	0.2–0.0	3	a .619 ± 6	" "
	0.0207	1 g Ag	0.2–0.0	3	a .593 ± 1	" "
	0.0140	0.6g	0.2–0.0	3	a .573 ± 2	" "
	0.0124	0.6	0.2–0.0	3	a .558 ± 2	" "
	0.01	0.6	0.2–0.0	3	a .554 ± 4	" "
Bukschnewski.						
CdI_2	0.0163m	0.3g Ag	0.1–0.00	3ex	a .578 ± 2	" "
	0.008–0.003	0.2	0.1–0.00	10	a .557 ± 2	" "
Redlich.						
$CdSO_4$	1.00m	1.6g Ag		3ex	a .746 ± 7	" "
	0.50	0.9		3	a .706 ± 13	" "
	0.251	0.9		4	a .677 ± 6	" "
	0.125	0.9		3	a .659 ± 2	" "
	0.0836	0.7	0.1	3	a .646 ± 4	" "
	0.0628	0.6		2	a .638 ± 5	" "
	0.0416	0.6	0.05	3	a .632 ± 5	" "
	0.0312	1.1	0.07	3	a .628 ± 3	" "
	0.0208	1.1	0.00	3	a .621 ± 3	" "
Metelka.						
$CuSO_4$	0.25–0.12m	0.9g Ag	0.1	6ex	a .672 ± 9	Cu "
	0.0820	0.9	0.2	3	a .634 ± 5	" "
	0.0625	0.9	0.3	3	a .627 ± 2	" "
	0.0416	0.9	0.2	3	a .626 ± 0	" "
	0.03–0.01	0.9	0.4–0.1	15	a .625 ± 3	" "

1901. W. Kistiakowsky.

Electrochemistry of Double Salts. Jour. Chem. Soc., *82*, II, 121; Zeit. f. Elektrochem., *8*, 71 (from Jour. Russ. Phys. Chem. Ges., *33*, 480, 592).

For apparatus see Kistiakowsky, 1890. From the author's measurements of $Ag_3Cr(C_2O_4)_3$, $K_4Fe(CN)_6$ and $K_3Co(CN)_6$ he concludes that the complex ions obey Kohlrausch's Law. Data are not quoted in the reviews.

1901. A. A. Noyes.

A Modification of the Usual Method of Determining Transference Numbers and an Investigation of the Influence of the Concentration on Their Values in the Case of Some Tri-Ionic Salts. Zeit. phys. Chem., *36*, 63. Jour. Am. Chem. Soc., *23*, 36. Phys. Rev., *12*, 15.

Apparatus: a pair of vertical U-tubes connected by a horizontal piece; capacity 1050 c.c.; Pt electrodes; no diaphragms. The solutions were kept neutral at the electrodes by adding acid and alkali during the electrolysis. The electrolyses were carried out at 25° C. In the fourth column are given the changes in the middle portions. The method of calculation is correct.

K_2SO_4	0.1m	3g Ag	0.3–0.03 percent	3ex	c.5069 ± 1.1
	0.02	0.5	0.3–0.03 "	3	c.5038 ± 0.5
$BaCl_2$	0.1m	2g Ag	0.1–0.05 "	4ex	c.5853 ± 0.3
	0.02	0.5	0.1–0.02 "	3	c.5578 ± 0.8
$Ba(NO_3)_2$	0.2m	2g Ag	0.02–0.01 "	4ex	ac.5450 ± 0.7
	0.04	0.5	0.003–0.00 "	3	ac.5437 ± 2.2

1901. A. A. Noyes and A. A. Blanchard.

Vorlesungsversuche zur Veranschaulichung der elektrolytischen Dissociation, der Gesetze des Gleichgewichts, und der Geschwindigkeit chemischer Vorgänge. Zeit. phys. Chem., *36*, 1.

Lecture experiments Nos. 5, 6, and 7 employ rather complex mixtures to show qualitatively by the direct method the migration of the ions of copper chromate, potassium hydrate, a mixture of hydrochloric acid and cupric chloride, and of potassium silver cyanide.

1901. W. Pfanhauser.

Ueber das elektrochemisches Verhalten des Nickelammonsulphats. Zeit. f. Elektrochemie, *7*, 698.

Apparatus: a U-tube with a glass vessel upon each end; Ni anode surrounded by a solution of ammonium sulphate; Pt cathode; parchment diaphragms.

$(NH_4)_2.Ni(SO_4)_2$ saturated solution	18° C		.507	
0.1m	18°	Ni	.118	toward cathode.
		NH_4	.272	
0.7m	50°		.499	

1901. E. Rieger.

Ueber die Konstitution halbkomplexer Salze nach ihrer elektrolytischen Ueberführung. Dissert. Breslau. Zeit. f. Elektrochemie, 7, 863, 871.

Apparatus: two vertical U-tubes joined by a sloping tube (capacity 60 c.c.); Pt. electrodes; no diaphragms; 0.4g Ag; middle portions unchanged.

The results below were calculated by the author for concentration changes in constant volume, not for constant amounts of water, as is correct. A Cu anode was employed in the experiments with copper sulphate, and an Ag anode with potassium mercury cyanide.

Lest the experimental results of this paper presented in a short summary should be misleading, I have introduced the fifth column below which records the number of monovalent equivalents moved from the cathode into the anode compartment while one equivalent of silver is precipitated in the voltameter: in the case of $K_2SO_4.CuSO_4$, the Cu moved toward the cathode. The sixth column gives Rieger's interpretation of the results.

In experiments with potassium ferrous oxalate the author found a small increase in the concentration of Fe at the anode.

$CuSO_4$	0.291m	5ex		a.67- ± 15
$CuSO_4.K_2SO_4$	0.291m	5	— 0.071 Cu	
	0.191m	3	— 0.074 Cu	
AgI 0.078m + KI 1.96 m		4ex	0.018 Ag	
HgI_2 0.214m + KI 0.782m		5ex	0.26 Hg	
$Hg(CN)_2.2KCN$ 0.810m		4ex	0.34 Hg	$Hg(CN)_4$ a.34- ± 10
$Zn(CN)_2$ 0.281m + KCN 1.087m		3ex	0.22 Zn	
$Cd(CN)_2.2KCN$	0.772m	5ex	0.30 Cd	$Cd(CN)_4$ a.29- ± 20
$K_3Fe(C_2O_4)_3$	0.408m	5ex	0.43 Fe	$Fe(C_2O_4)_3$ a.43- ± 20

1901. E. H. Riesenfeld.

Ueber elektrolytische Erscheinungen an der Grenzfläche zweier Lösungsmittel. Zeit. f. Elektrochem., 7, 645.

An entirely new method. An electrolyte is dissolved in two not completely miscible solvents so that these are in equilibrium

with each other, and the two solutions are placed in a U-tube so that there is a layer of the lighter solution in both arms surrounding the electrodes while the heavier fills the bottom of the tube. If now an electrochemical equivalent of current be sent through, there will have occurred in the one meniscus an increase of concentration, in the other a decrease, both equal to the difference in migration value in the two solvents. This accumulation in the boundary is divided between the surface layers of the two liquids in the relation of the distribution ratio (Verteilungscoefficient), and is removed from them in proportion to the rates of diffusion in the two solvents. Hence in a favorable case where the product of the distribution ratio and the square root of the ratio of the rates of diffusion is large, practically all the accumulated electrolyte goes into the electrode solution. Hence from analysis of the electrode solution before and after electrolysis we may measure the migration value in the solvent in the middle of the tube. The fact that with potassium iodide the value, 19– was obtained under variation of the concentration (from 0.029 m to 0.13 m in the aqueous solution), the volume of electrode solution, and the current density is regarded as a proof of the correctness of the theoretical treatment. For potassium dichromate, ferric sulphocyanate, and ortho-nitro-phenol the migration value of the anion is greater than in aqueous solution.

1901. **B. D. Steele.**

A New Method for the Measurement of Ionic Velocities in Aqueous Solution. Trans. Chem. Soc., 79, 414. Zeit. f. Elektrochem, 7, 618.

Apparatus: an H-tube with electrode chambers attached. The H-tube contained the aqueous solution to be investigated; while the electrode chambers were filled with an "indicator" solution solidified by gelatine. The author measured the ratio between the rates at which the tube's two surfaces of contact approached each other; the boundaries being detected by the difference in refraction. The indicators employed had one ion in common with the solution to be measured, while the specific velocity of the other ion was less than that of the ion it followed through the H-tube. Under these conditions the observed rates are proportional to the specific ionic velocities.

Two determinations with $MgSO_4$ in 2 m solution by the analytical (Hittorf) method are published without data; $n = .732$ and .744.

The third column in the table below gives the indicators employed. "Most of the experiments were carried out at 14° C." No allowance was made for cataphoresis.

$MgSO_4$	2.0m	$CuSO_4$, K_2CrO_4		ac.729
	2.0m	" "		ac.688 (in gelatine)
	2.0m	" $NaC_2H_3O_2$		ac.734
	2.0m	$CdSO_4$, "		ac.738
	2.0m	LiCl, "		ac.56– to .61–
NaCl	2.0m	" "		ac.590
	1.0	" "		ac.592
	0.5	" "		ac.597
KCl	2.0m	" "	6ex	ac.489
	1.0	" "		ac.488
	0.5	" "		ac.490
KBr	2.0m	" "	6ex	ac.468
	1.0	" "	2	ac.473
	0.5	" "	5	ac.478
	0.1	" "		ac.483
NaBr	0.5m	" "		ac.595
$CdSO_4$	2.0m	" "		ac.62– to .65–

1901. **A. Wiesler.**

Beiträge zur Kenntnis der Metaphosphate. Zeit. anorg. Chem., *28*, 190.

Apparatus same as used by Jahn, capacity of anode 200 c.c.; Zn anode, Hg cathode; no diaphragms; method of calculation correct.

$NaPO_3$	0.039m	0.65g Ag	1 percent	2ex	a.590 ± 0

1902. **R. Abegg und W. Gaus.**

Beiträge zur Theorie der direkten Bestimmungsmethode von Ionenbeweglichkeiten. Zeit. phys. Chem., *40*, 737.

The apparatus and method were the same in principle as those used by Steele, 1901 and 1902, but modified to measure the cataphoresis.

NaCl	3 percent	LiCl, $NaC_2H_3O_2$	7ex	ac.606 varied potential fall.
KCl	0.5m ?	" "	1ex	ac.508 corrected for cataphoresis.

1902. **A. Coehn.**

Ein Beitrag zur Oxoniumtheorie. Ber. *35*, III. 2673.

The author showed that when a solution of 20 percent hydrochloric acid and 20 percent di-methyl-pyrone is placed between electrode solutions of 10–20 percent hydrochloric acid, that the

di-methyl-pyrone moves into the cathode compartment. The first apparatus was a beaker into which dipped tubes closed underneath with parchment and containing the electrodes and hydrochloric acid. The second was a vertical U-tube, the upper halves of whose arms were attached by ground glass joints so that they could be separated by sliding horizontally; the lower half contained the di-methyl-pyrone.

1902. **F. G. Donnan, H. B. Bassett and C. J. J. Fox.**

The Color Changes exhibited by the Chlorides of Cobalt and some other Metals, from the standpoint of the Theory of Electroaffinity. Jour. Chem. Soc., *81*, 939.

Two electrode chambers are connected by a horizontal tube closed at each end by a plug of plaster of Paris. When the electrode compartments were filled with strong solution of calcium chloride and blue cobalt chloride, and the horizontal tube with calcium chloride solution, the blue color traveled down the tube toward the anode. When the end vessels contained red cobalt chloride and the tube potassium chloride, the red color moved toward the cathode. Cataphoresis was not measurable. Further experiments were performed in a U-tube, the lower half containing the heavy solution, and both arms the other (electrode) solution.

	Lower Colored Layer.	Upper Colorless Layer.
(1)	$CoCl_2$ (blue) in concentrated HCl	concentrated HCl
(2)	" " " " $MgCl_2$	" $MgCl_2$
(3)	" " " " $CaCl_2$	" $CaCl_2$
(4)	fairly dilute $CoCl_2$ (red)	KCl
(5)	$CoCl_2$ (red) + concentrated $CaCl_2$ and $ZnCl_2$	concentrated $CaCl_2$ + $ZnCl_2$
(6)	Fehling's solution	alkaline tartrate solution
(7)	ammoniacal copper sulphate	$NH_4OH + NH_4SO_4$
(8)	$CoCl_2$ (blue) in alcohol	$CaCl_2$ or HCl in alcohol
(8*a*)	$CoCl_2$ (red) in alcohol at $-79°$	$CaCl_2$ or HCl in alcohol
(9)	$CoCl_2$ (red) + $HgCl_2$ in alcohol	$HgCl_2$
(10)	" " " " " "	HCl
(11)	$FeCl_3$ in concentrated HCl	(concentrated HCl) ?
(12)	$CuCl_2$ " " "	" "

In (1), (2), (3), (6), (8), the blue color moved toward the anode; in (4), (5), (7), (9) and (8*a*) the red color moved towards the cathode; in (10) the blue meniscus on the anode side moved off toward the anode leaving a colorless layer above the red solution, at the cathode side the blue color at the meniscus ex-

tended itself down into the red layer, although the meniscus remained stationary; in (11) and (12) the brownish yellow moved toward the anode.

The foregoing experiments, the general behavior, the freezing points and conductivity alone and mixed, etc., are all consistently explained by the authors' conclusion that the simple cobalt cation is red, and that the blue is a complex anion $CoCl_3'$ or $CoCl_4''$. Similarly the brownish yellow of ferric and copper chlorides is attributed to a complex anion.

1902. W. Hittorf.

Bemerkungen über die Bestimmungen der Ueberführungszahlen der Ionen während der Elektrolyse ihrer Lösungen. Das Verhalten der Diaphragmen bei derselben. Arch. Neerl. (2) *6*, 671; Zeit. phys. Chem., *39*, 613; *43*, 239. Drude's Ann., *9*, 243.

Apparatus: N-shaped tubes and superposed glasses; capacity of anode vessel 20–40g; no middle portion. Various diaphragms were employed, viz.: bolting silk (bolt), earthenware (earth), intestinal membrane (darm) and gold beaters' skin (gold). Anode Cd, the cathode is indicated below in the fourth column. One experiment each.

The author observed with a differential spectroscope the currents occasioned in the solutions by the diaphragms; these occurred only with the chlorides of cadmium, calcium, barium, and strontium, the nitrates of silver and thallium, and the strong free acids; not with the nitrates, acetates, and iodides of the alkalis. The action is described as the splitting up of the solution into a more concentrated and a more dilute, which are ejected at opposite sides of the diaphragm. The diaphragms which modify the transport number are: intestinal membrane, gold-beaters' skin, membrane of an egg, and gelatine. Without influence are: agar agar, and earthenware.

$CuSO_4$	0.656 m	16°	1.1g Ag	Hg	darm	a .714
$BaCl_2$	0.125 m	25°	0.8g Ag	Pt	bolt	a .644
	0.125	25°	1.0	"	earth	a .648
	0.0908	23°	0.3	"	bolt	a .576
	0.0908	23°	0.3	"	bolt. earth	a .575
$CaCl_2$	0.123 m	20°	0.7g Ag	"	bolt	a .675
	0.0551	20°	0.2	"	earth	a .596
$MgCl_2$	1.40 m	23°	0.5g Ag	"	bolt	a .719
	0.104	24°	0.2	"	"	a .649

$CdCl_2$	7.69 m	22°	1.4g Ag	Hg	none	a1.137
	2.61	19°	0.7	"	"	a .801
	1.33	19°	1.5	"	"	a .724
	0.372	17°	0.8	"	"	a .589
CdI_2	1.61 m	17°	0.5g Ag	"	"	a1.245
$ZnCl_2$	3.56 m	18°	1.0g Ag	"	"	a1.241
$CdCl_2$	0.101 m	17°	0.3g Ag	"	"	a .565
	0.101	17°	0.3	"	earth	a .568
	0.101	17°	0.3	"	darm	a .743
	0.101	16°	0.2	"	darm, earth	a .564
	0.0704	22°	0.5	"	darm	a .737
	0.0965	17°	0.3	"	"	a .593
	2.70	19°	0.5	"	"	a .844
	1.57	17.5°	0.5	"	gold	a .802
	1.49	18°	0.4	"	"	a .801
	0.0404	19°	0.2	"	"	a .752
	0.0131	18.9°	0.1	"	"	a .636
	0.11		0.5	"	solidified by gelatine	a .551
KCl	0.226 m	17°	0.4g Ag	Pt	darm	a .509

1902. **H. Morse.**

Ueber die Dissociation der Merkurihaloide. Zeit. phys. Chem., *41*, 709.

By qualitative measurements it was found that when the following chemicals are dissolved in strongly acid mercuric nitrate solutions and electrolysed, the halogen increases in concentration in the cathode solution: AgCl, $HgCl_2$, AgBr, $HgBr_2$, AgI, HgI_2; the property increasing in the order mentioned. The preliminary experiments were performed in a U-tube, the solution being solidified with agar agar and the upper half of the tube being filled with silver nitrate; cataphoresis was pronounced. The final experiments were made in two beakers connected by a siphon without diaphragms.

1902. **A. A. Noyes and G. V. Sammet.**

The Equivalent Conductivity of the Hydrogen Ion derived from Transference Experiments with Hydrochloric Acid. Jour. Am. Chem. Soc., *24*, 944. Zeit. phys. Chem, *43*, 49.

Apparatus: a pair of vertical U-tubes connected by a horizontal piece; capacity 1300 c.c.; Pt electrodes; no diaphragms; calculation correct.

The paper further contains measurements of the conductivity of the hydrochloric acid.

In the following table the results discarded by the authors are omitted.

HCl	0.050 m	20°	0.8g Ag	0.6–0.00 percent	9ex	ac.1657 ± 2.3
	0.017	20°	0.3	0.5–0.00 "	11	ac.1674 ± 1.9
	0.017	10°	0.3	0.1–0.00 "	6	ac.1586 ± 1.3
	0.017	30°	0.3	0.6–0.00 "	6	ac.1773 ± 0.6
	0.0056	20°	0.18	0.2 "	10	ac.1671 ± 2.7

1902. E. H. Riesenfeld.

Bestimmung der Ueberführungszahl einiger Salze im Phenol. Drude's Ann., *8*, 609.

For apparatus and method see Riesenfeld, 1901 ; Pt electrodes.

KI	0.03–0.2 m	13°–20°	0.2 g Ag	c.191
KBr	0.134 m	14°	0.27g Ag	c.196
KCl	0.212 m	15°–16°	0.3 g Ag	c.192
LiCl	0.167 m	15°	0.25g Ag	c.229

1902. H. Schlundt.

On the Relative Velocities of the Ions in Solutions of Silver Nitrate in Pyridine and Acetonitrile. Jour. Phys. Chem., *6*, 159.

Apparatus: similar to a Gay-Lussac's burette, Ag cathode at top, Ag anode at bottom; capacity 30 c.c. and 60 c.c.; no diaphragm; middle portion changed less than 1 percent; method of calculation correct.

$AgNO_3$ in Pyridine				
1.0 m	23°	0.17g Ag	1ex	ac.673 ± 1
0.5	0°–23°	0.16	3	ac.661 ± 4
0.1	0°–21°	0.16	3	ac.603 ± 9
0.025	22°	0.05	2	ac.559 ± 8
$AgNO_3$ in Acetonitrile				
1.0 m	18°	0.2 g Ag	1ex	ac.616 ± 2
0.275	19°	0.12	1	ac.578 ± 2
0.091	17°	0.12	1	ac.551 ± 4
0.029	19°	0.08	1	ac.529 ± 2

1902. B. D. Steele.

Die Messung von Ionengeschwindigkeiten in wässerigen Lösungen, und die Existenz komplexer Ionen. Zeit. phys. Chem., *40*, 689. Phil. Trans., *198*, 105. Jour. Chem. Soc., *79*, 414.

For apparatus and method, see Steele, 1901. The indicators (normal solutions) were $CuSO_4$ with Cu anode, $LiCl + Li_2CO_3$, $MgCl_2 + MgO$, $CdSO_4$ with Cd anode, $Na.C_2H_3O_2 + H.C_2H_3O_2$, $KF + H.C_2H_3O_2$.

Observations made at the indicator boundaries showed the existence of complex anions in solutions of KI_3 and $KFe'''Ox$.

KCl	0.5–2.0 m	LiCl, $NaC_2H_3O_2$	ac.489 + 1
NaCl	0.5 m	" "	ac.597
	1.0	" "	ac.591
	2.0	" "	ac.590

KBr	0.1 m	LiCl, $NaC_2H_2O_2$	ac.483
	0.5	" "	ac.478
	1.0	" "	ac.473
	2.0	" "	ac.468
$KBrO_3$	0.29 m	" "	ac.385
NaBr	0.5 m	" "	ac.595
LiCl	0.5 m	$CdSO_4$, "	ac.716
	1.0	" "	ac.751
KOH	0.574 m	LiCl, KBr	ac.730
$AgNO_3$	1.15 m	$CuSO_4$, KFl	ac.486
$BaCl_2$	0.25 m	$MgCl_2$, $NaC_2H_3O_2$	ac.576
	0.5	" "	ac.619
	1.0	" "	ac.633
$SrCl_2$	0.25 m	" "	ac.625
	0.5	" "	ac.665
	1.0	$CuSO_4$ "	ac.709
$CaCl_2$	0.25 m	$CdSO_4$ "	ac.681
	0.5	" "	ac.697
	1.0	$CuSO_4$ "	ac.715
$MgCl_2$	0.25 m	$CdSO_4$, "	ac.705
	0.5	" "	ac.722
	1.0	$CuSO_4$ "	ac.740
$MgSO_4$	0.092 m	$CdSO_4$ "	ac.646
	0.25	" "	ac.693
	0.5	" "	ac.715
	1.0	" "	ac.737
$CuSO_4$	0.5 m	" "	ac.66–
	1.0	" "	ac.73–
K_2CrO_4	0.25 m	LiCl "	ac.447
	1.0	" "	ac.403
KFe'''Ox	0.603 m	" "	ac.331

1902. B. D. Steele and R. B. Denison.

The Transport Number of very Dilute Solutions. Trans. Chem. Soc., 81, 456.

Apparatus: a W-tube arranged so that a current of unaltered solution could be passed down through the inside legs, so that the middle portion was continually renewed; this made the total quantity of liquid for analysis in each half of the apparatus three liters; no diaphragms; Pt electrodes surrounded with alkali and acid respectively; calculation correct.

$CaSO_4$	0.0045 m	0.3g Ag	0.4–2 percent	6ex	c.559 ± 13
$Ca(NO_3)_2$	0.0047 m	0.4g Ag	2–0.4 "	3ex	c.550 ± 3
$CaCl_2$	0.0046 m	0.4g Ag	2–0.3 "	3ex	c.562 ± 6
KCl	0.0025–0.0046m	0.4g Ag	1–0.06 "	9ex	c.505 ± 4

Proc. Wash. Acad. Sci., June, 1907.

1903. G. Carrara.

Per la teoria della dissociazione elettrolitica in solventi diversi dall'acqua. III. Influenza del solvente sopra i numeri di trasporto. Gazz. chim. *33*. I, 241.

Apparatus: (i) see Loeb and Nernst; capacity 30 c.c.; (ii) cylindrical glasses superposed on one branch of a U-tube, the bottom of each being closed by fish bladder; capacity 40–70 c.c.; (iii) an M-tube without diaphragms with outlets on the three lower extremities; capacity 100 c.c.; two middle portions with a change 2–20 percent as great as the end portions; 25°C. The method of calculation is correct. The unusual duration of the experiments (up to 50 hours) must have occasioned mixing by diffusion and convection. The solvent was in all cases pure methyl alcohol.

			Anode.	Cathode.		
$AgNO_3$	0.0093 m	0.03g Ag	i	Ag/Pt	3ex	ac .489 ± 23
$Cu(NO_3)_2$	0.125 m	0.2 g Ag	i	Cu/Pt	3ex	a .454 ± 9 c .375 ± 70
	0.111	0.2	i	"	4	a .491 ± 18 c .285 ± 68
$Cd(NO_3)_2$	0.02–0.05 m	0.7 g Ag	i	Cd/Pt	3ex	ac .430 ± 10
$LiNO_3$	0.260 m	0.8 g Ag	i	"	1ex	ac .765 ± 6
	0.260	0.7	ii	"	2	ac .753 ± 20
	0.21	0.7	ii	Pt or Cd/Pt	2	ac .710 ± 37
$AgClO_3$	0.0118 m	0.03g Ag	i	Ag/Pt	3ex	a .418 ± 4 c .377 ± 10
$Cu(ClO_3)_2$	0.114 m	0.4 g Ag	i	Cu/Pt	3ex	a .580 ± 14 c .42- ± 65
$LiClO_3$	0.19 m	0.6 g Ag	i[1]	"	1ex	ac .707 ± 11
	0.14	0.4	i[1]	Cu or Pt/Pt	2	ac .719 ± 15
$Cd(ClO_3)_2$	0.083 m	0.5 g Ag	i	Cd/Pt	2ex	ac .273 ± 8
	0.024	0.15	i	"	2	ac .223 ± 9
$CuCl_2$	0.189 m	0.6 g Ag	iii	Cu/Pt	1ex	ac .642 ± 0
	0.062	0.25	iii	"	1	ac .629 ± 5
$CdCl_2$	0.0558 m	0.1 g Ag	iii	Cd/Pt	2ex	ac .736 ± 10
	0.0380	0.14	iii	"	1	ac .627 ± 21
	0.0254	0.04	iii	"	2	ac .608 ± 6
CdI_2	0.1060 m	0.1 g Ag	i	"	2ex	ac 1.409 ± 1
	0.0532	0.1	i	"	2	ac 1.270 ± 17
	0.0243	0.05	i	"	2	ac 1.211 ± 19
LiI	0.02–0.1 m	0.3 g Ag	ii	"	3ex	ac .632 ± 21
	0.057	0.16	iii	"	1	ac .590 ± 9
$N(C_2H_5)_4.I$	0.048 m	0.03g Ag	ii	"	1ex	ac .764 ± 3
	0.0260	0.09	iii	"	1	ac .730 ± 0
$S(CH_3)_3.I$	0.091 m	0.17g Ag	iii	"	1ex	a .623 c .568

[1] With fish-bladder diaphragms.

$Cd.(C_2H_3O_2)_2$	0.0515 m	0.1 g Ag	i	"	2ex	ac	.240 ± 8
	0.0275	0.1	i	"	1	ac	.167 ± 2
$Cu.(C_2H_3O_2)_2$	0.0174 m	0.08g Ag	ii	Cu/Pt	2ex	c	.594 ± 29
$Li.C_2H_3O_2$	0.29 m	0.6 g Ag	ii	Cd/Pt	2ex	ac	.515 ± 9
$CuSO_4$	0.168 m	0.2 g Ag		Cu/Pt	4ex	ac	.356 ± 38

1903. **A. Charpentier.**

Sur le transport électrolytique de certains ions dans la gélatine. Comptes rendus, *136*, 1652.

The author finds that the chromate ion of chromic acid and potassium bichromate moves in gelatine toward the anode with velocity comparable to that of $H^{\cdot}$ or OH'; no reference is made to cataphoresis.

1903. **R. B. Denison.**

Beiträge zur direkten Messung von Ueberführungszahlen. Zeit. phys. Chem., *44*, 575.

For apparatus and method, see Steele, 1901; allowance for cataphoresis as in Abegg und Gaus, 1902. In some of the experiments with strontium chloride and lithium chloride the solutions contained gelatine, liquid or solid as indicated below. Electrodes Cu. A qualitative experiment showed the existence of complex anions in copper acetate solution.

NaCl	0.5m	LiCl, $NaC_2H_3O_2$	5ex	ac.618 ± 1	
NaBr	0.5m	" "	6ex	ac.619 ± 6	
KCl	0.5m	" "	3ex	ac.510 ± 2	
KBr	0.5m	" "	4ex	ac.505 ± 3	
K_2CrO_4	0.5m	" "	4ex	ac.484 ± 4	
$CaCl_2$	0.5m	$CdSO_4$, "	3ex	ac.666 ± 1	
$MgCl_2$	0.5m	" "	3ex	ac.685 ± 3	
	1.0	" "	3	ac.697 ± 0	
$MgSO_4$	0.5m	" "	3ex	ac.682 ± 2	
	1.0	" "	3	ac.698 ± 0	
	2.0	" "	3	ac.717 ± 3	
LiCl	0.5m	" "	3ex	ac.718 ± 2	
	1.0	" "	4	ac.734 ± 5	
	0.5	—, $Cu(C_2H_3O_2)_2$?	2	ac.738 ± 0	solid gelatine
	1.0	" "	2	ac.729 ± 4	" "
$SrCl_2$	0.5m	$CdCl_2$, $NaC_2H_3O_2$	2ex	ac.635 ± 0	
	1.0	$MgCl_2$, "	4	ac.641 ± 1	
	0.5	Cu, —	4	ac.652 ± 3	solid gelatine
	1.0	" "	2	ac.671 ± 1	" "
	0.5	Mg, —	3	ac.634 ± 1	gelatine liquefied
	1.0	" "	1	ac.648	" "

1903. Goldberger.

(Quoted by W. A. Roth Zeit. phys. Chem., *42*, 210, from unpublished experiments.)

$BaCl_2$. In the following table the volume percent of ethyl alcohol is given at the head of the column, the concentration of the barium chloride in the first column.

	0	*10*	*20*	*25*	*30*	*40*
0.033m	.543	.531	.540	.549	—	.533
0.017	.548	.536	.543	.551	.545	.536
0.011	.553	.545	.547	.550	—	.536
0.008	.554	.546	—	—	—	—

1903. Hornbostel.

(Quoted by W. A. Roth, Zeit. phys. Chem. *42*, 210, from unpublished experiments.)

KCl	0.034-0.0084m	18°	12ex	$-.494 \pm 4$ in 10 volume percent alcohol.
	0.034-0.011	18°	9	$-.481 \pm 5$ " 25 " " "

1903. R. Kremann.

Ueberführungsversuche zur Entscheidung der Konstitution von Salzen. Zeit. anorg. Chem., *33*, 87 (see also polemic, ibid., *35*, 48).

The formulæ of Werner for purpureo-cobalt-chloride $(ClCo(NH_3)_5).Cl_2$ was confirmed by the movement of the colored solution (rendered heavier by cane sugar) toward the cathode when electrolyzed in a U-tube between an anode solution of Na_2SO_4 and a cathode solution of H_2SO_4; for the praseobisulphate, by its similar behavior; and for diamine-cobalt-potassium-nitrite, by its movement toward the anode, between solutions of H_2SO_4 (anode) and acetic acid (cathode). The results were checked by direct electrolysis of the pure solution in a W-shaped tube and analysis of the solution in the neighborhood of the electrode; in the case of chlorpurpureo-cobalt-nitrate $(ClCo(NH_3)_5).(NO_3)_2$ the amount of chlorine in the neighborhood of the zinc cathode increased on electrolysis, and was lessened at the anode; in the case of the diamine-cobalt-potassium-nitrite the cobalt collected in the neighborhood of the anode.

Bredig's conception of methyl orange as an amphoteric electrolyte was discredited by the fact that when a strongly acid solution was electrolyzed in a U-tube between solutions of acid no movement of the colored layer toward the cathode could be detected; on the other hand, when the methyl orange solution was only weakly acid, or alkaline, the colored solution moved toward the anode.

The existence of "copper-, cobalt-, and nickel-phosphites" (*e. g.*, $Na.CuPO_3$) is deduced from the movement of the heavy metal toward the anode.

The movement toward the anode of the green solution of chromic hydroxide in strong alkali demonstrates the existence of chromites; the chromic hydroxide is not merely dissolved as colloid, for it can diffuse through parchment into alkaline solution. Similarly the zinc in potassium zincate becomes more concentrated at the anode.

1903. **S. C. Lind.**

The Constitution of Potassium Ruthenium Nitroso-chloride in Aqueous Solution. Jour. Am. Chem. Soc., *25*, 928.

A 0.025 m solution was connected by siphons containing 0.05 m potassium chloride solution solidified by agar agar with anode and cathode compartments containing Pt electrodes surrounded by hydrochloric acid and potassium hydrate respectively. A pink color moved toward the anode while no color change occurred in the cathode siphon. This shows that ruthenium is contained in an anion, presumably $RuCl_5NO''$; the author further concluded that it proved that no cation contains ruthenium.

1903. **J. W. McBain.**

Electrolytic Migration in Solutions of the Weak Acids. This paper has not been published in full; abstracts have appeared in Trans. Roy. Soc. Canada, May, 1903, and 1904, and in Trans. Am. Electrochem. Soc., *4*, 184. (1903).

Apparatus: many forms, mostly pairs of U tubes; capacity 40–350 c.c.; Pt. electrodes; 0.04g Ag; diaphragms of cloth or bundles of small tubes; 2–5 middle portions, the real one unchanged within 0.00 to 0.05 c.c. of decinormal alkali.

The author eliminated the irregular and uncontrollable reactions occurring at the electrodes during the electrolysis of acetic and propionic acids, which would otherwise have discredited the results, by surrounding the electrodes with long columns of solutions of sodium sulphate, sulphuric acid, hydrochloric acid, etc. This made the apparatus complicated and the manipulation difficult. The electrode solutions were carefully tested for in the middle portions, but were usually altogether absent, and in no case present in quantity sufficient to cause an error of 20 percent in the result. An experiment with hydrochloric acid,

using the same apparatus and protecting solutions gave a normal result.

$H.C_2H_3O_2$	0.02–1.0m	30°	17ex	ac.31–
$H.C_3H_5O_2$	0.1m	30°	1	ac.34–
HCl	0.018m	30°	1	ac.19–

1903. **P. Straneo.**

Zeit. phys. Chem., *44*, 640, from Rendic. Accad. Lincei, 1902. *1*, 58. 171.

The author measured the E.M.F. between two electrodes placed in a solution of zinc sulphate just after a momentary current had been passed through; the migration value calculated from the concentration changes thus indicated agreed with that obtained by the usual analytical method.

1903. **F. Vogel.**

Untersuchungen über Nitrite. Zeit. anorg. Chem., *35*, 410.

Apparatus like Jahn's; capacity of anode compartment 187 c.c.; Cd anode; middle portion unchanged. The barium was determined as $BaSO_4$. The results are calculated incorrectly (based on constant weight of solution instead of constant amount of water).

$Ba(NO_3)_2$	0.025–0.032m	0.3–0.6g Ag	2ex	a.588 = 6

1904. **F. Aletter.**

Die Jonenkonzentrationen ternärer Elektrolyte. Dissert. Rostock, results quoted by Kümmel, Zeit. f. Elektrochem., *11*, 98, 1905.

Pt electrodes; no middle portion; capacity of cathode compartment 100 c.c.; method of calculation incorrect (based on constant volume of solution instead of on constant amount of solvent). Further I think the number given below as the migration of the C_2O_4'' ion is really that of the cation $K^{\cdot}$. In the case of lithium sulphate Aletter's calculation contains, in addition to the two systematic errors I have already mentioned, the further assumption that SO_4'' is monovalent. In the last column I have eliminated all but the first error.

				Aletter.	McBain.
$K_2C_2O_4$	1.0 m	16°	0.2 g Ag	c.24–	.76–
	0.5	16°	0.17	c.262	.738
Li_2SO_4	1.0 m	16°	0.27g Ag	a.652	.696
	0.5	16°	0 28	a.63–	.74–
	0.25	16°	0.17	a.60–	.80–

1904. **J. S. Bridges.**

The Transference Numbers of Copper Chloride in Concentrated Solution. Thesis presented for degree of B.Sc. Mass. Inst. of Tech., Boston.

Inaccessible in Heidelberg.

1904. C. H. Burgess and D. L. Chapman.

The Nature of a Solution of Iodine in Aqueous Potassium Iodide. Jour. Chem. Soc., *85*, 1305.

The authors deduce from the results of the comprehensive study of solutions of iodine in potassium iodide by previous investigators that KI and KI_3 are equally "strong" (*i. e.*, the dissociation constants are equal). Proceeding from this, and making use of the equilibrium constant for $I_2 + I' = I_3'$, they show that the relative rates of the I_3' and I' ions may be deduced from the migration value (that of KI being known) and independently by the measurement of the conductivity of potassium iodide solutions with and without the addition of iodine.

Apparatus: too complex for description without a figure; Pt electrodes; no middle portion; no diaphragms; 25°C.; the results are based (inaccurately) on constant volume of solution instead of constant weight of water. The KI was from 0.025 m to 0.5 m, the added I_2 0.0075–0.06 m.

The transport method gave as ratio of the mobilities of the I_3 and the I ions 0.556; the conductivity method 0.553.

1904. C. Dempwolff.

Jonenwanderung in Methylalkohol als Lösungsmittel. Zeit. f. Elektrochem., *11*, 124 (from Physik. Zeit., *5*, 637).

Apparatus shaped like an N with branch at right hand upper corner; no diaphragms; Ag, Cd, and Pt electrodes; 19°.

KI	0.336m	ac.49–	LiBr	0.719m	ac.69–	LiCl	0.840m	c.67–
	0.167	ac.44–		0.234	ac.65–		0.182	c.59–
	0.080	ac.37–		0.087	ac.56–		0.096	c.54–
	0.049	ac.33–		0.046	ac.55–		0.083	c.53–
	0.019	ac.32–					0.049	c.52–
$AgNO_3$	0.096m	ac.58–	KCl	0.039m	c.47–	KBr	0.092m	ac.45–
	0.049	ac.56–		0.021	c.44–		0.052	ac.43–
	0.033	ac.56–		0.017	c.44–		0.034	ac.42–
	0.024	ac.56–						
$NaCH_3O$	(Sodium methylate)		NaI	0.0803m	ac.55–			
	0.079m	ac.67–						
	0.037	ac.58–						
	0.026	ac.56–						

1904. E. C. Franklin and H. P. Cady.

On the Velocities of the Ions in Liquid Ammonia Solutions. Jour. Am. Chem. Soc., *26*, 499.

As the Journ. Am. Chem. Soc. is inaccessible in Heidelberg, I have abstracted this paper from Danneel's reviews (Beiblätter,

28, 971, and Zeit. f. Elektrochem., *11*, 109). Apparently two methods were used, both being meniscus-velocity methods. The simultaneous measurement of the velocities of the anion and cation succeeded only in the case of NH_4NO_3. The other measurements were made in a complex "sehr sinnig ausgedachtem" apparatus, and the migration values were deduced with the help of conductivity measurements. The indicators used were Hg-, Pb-, Cu- and Bi-salts at the anode, and picric acid at the cathode. The concentrations lay mostly between 0.5 and 0.01 m; temperature — 34°C. In NH_4Cl and NH_4Br the migration value increases rapidly with the concentration.

NH_4NO_3 .570 KNO_3 .501 $NaNO_3$ .574 NaCl .581 $AgNO_3$ .614

1904. H. C. Jones and H. P. Bassett.

Determination of the Relative Velocities of the Ions of Silver Nitrate in Mixtures of the Alcohols and Water, and on the Conductivity of such mixtures. Am. Chem. Jour., *32*, 409.

Apparatus: an M-tube with a glass tap in the middle dividing the whole into a cathode and an anode portion; capacity 130 c.c.; Ag electrodes; no diphragms; no middle portion; the results are incorrectly calculated (based on volume of solution, not amount of solvent). In the last column below is given the solvent; the authors do not mention whether the mixtures were made by weight or by volume.

$AgNO_3$					
0.1 m	25°	0.35g Ag	5ex	ac.529 ± 8	water
0.102	0°	0.12	3	ac.563 ± 0	"
0.08–0.1	25°	0.08	6	ac.598 ± 11	ethyl alcohol
0.10	25°	0.15	5	ac.580 ± 8	methyl alcohol
0.97	0°	0.06	5	ac.587 ± 6	" "
0.1	25°	0.12	3	ac.554 ± 3	25% methyl alcohol, 75% water
0.104	0°	0.08	8	ac.538 ± 10	25 " " " 75 " "
0.104	25°	0.11	3	ac.601 ± 5	50 " " " 50 " "
0.105	0°	0.6	3	ac.530 ± 1	50 " " " 50 " "
0.105	25°	0.08	5	ac.590 ± 3	75 " " " 25 " "
0.098	0°	0.06	6	ac.567 ± 2	75 " " " 25 " "

1904. V. Kohlschütter.

Ueber komplexe Kupferverbindungen. Ber., *37*, 1, 1153.

Apparatus: four U-tubes connected by siphons; capacity 12 c.c.; no middle portions. On account of the extraordinary influence of the concentration on the migration value I have given in the second column below directly the weight of $CuCl_2$

in 1000 g. H_2O. In qualitative experiments it was found that the yellow color of a concentrated solution of cupric chloride in hydrochloric acid moved toward the anode into a concentrated solution of hydrochloric acid or magnesium calcium or lithium chloride, proving the presence of complex anions. When concentrated cupric chloride solution was electrolysed between layers of ammonium or sodium sulphate or acetate, the boundary on the anode side remained stationary, while a blue color moved towards the cathode. The method of calculation is correct. I think that the probable explanation of the extraordinary influence of the concentration on the migration value is to be sought for in the excessive hydration of the cation. Surely the fourth experiment must be a mistake.

$CuCl_2$	711.3g = 5.29 mols		0.67g Ag	1ex	c	1.835
	584.4g = 4.35 "		0.37	1	c	1.632
	500.9g = 3.72 "		0.37	1	c	1.411
	445.4g = 3.3 "		0.53	1	c	—0.795
	357.5g = 2.66 "	— 1.35°	0.39	1	c	.817
	357.5g = 2.66 "	+ 17.95°	0.47	1	c	1.042

1904. T. W. Richards and F. Bonnet.

Das veränderliche hydrolytische Gleichgewicht von gelöstem Chromsulphat. Zeit. phys. Chem., *47*, 46. Proc. Am. Acad. Arts and Sci., June, 1903.

Apparatus: four glasses superposed upon a U-tube; Cd electrodes; parchment diaphragms.

A solution of green chromium sulphate saturated with chromic hydroxide was placed in the middle vessel while the four other vessels were filled with a solution of cadmium sulphate. No chromium was moved towards the anode; $n = .26$ — if the cation containing chromium is divalent, $n = .63$ — if monovalent. The possibility of the presence of a colloid is not discussed.

1904. O. F. Tower.

Transport number of Sulphuric Acid. Jour. Am. Chem. Soc., *26*, 1038. Jour. de chim. physique, *3*, 1. [Abs. W.L.M.]

Apparatus: two U-tubes with side apertures connected by rubber tubing, 40 cm. long and 3 cm. diameter; in a smaller apparatus (S.A.) the diameter was 2 cm. Anode, Cd; cathode, Pt spiral. Average current 0.07 amp, in a few cases twice as much. Duration of electrolysis, 2–3 hours. After electrolysis the solution was analyzed in 5 portions; in every case the composition of the middle portion remained constant within the error

of analysis, *i. e.*, 0.0009g of H_2SO_4 for normal and half normal acid, and 0.0005g for more dilute solutions.

H_2SO_4	normal	20°	0.74g Ag	3ex	ac.188 ± 6 (S.A.)
	"	20	0.6–1.4	6	ac.188 ± 9
	0.5n	20	0.7–1.3	6	ac.187 ± 6
	0.2	20	0.8	6	ac.180 ± 7 (S.A.)
	0.1	8	0.7	6	ac.164 ± 4
	0.1	20	0.7	6	ac.174 ± 6 (S.A.)
	0.1	20	0.7	6	ac.176 ± 1
	0.1	32	0.6	6	ac.192 ± 1
	0.05	8	0.4	6	ac.164 ± 2
	0.05	20	0.3	4	ac.176 ± 4 (S.A.)
	0.05	20	0.3–0.6	6	ac.179 ± 3
	0.05	32	0.5	6	ac.192 ± 2
	0.02	8	0.2	6	ac.168 ± 2
	0.02	20	0.25	6	ac.181 ± 3
	0.02	32	0.25	6	ac.191 ± 3

The author considers the following to be the most trustworthy results; but thinks that .1764 for $n/10$ acid at 20° is "for some unaccountable reason" too low.

Concentration.	Temp. 8°	20°	32°
Normal	—	.1877	—
0.5n	—	.1869	—
0.2	—	.1805	—
0.1	.1644	.1764	.1917
0.05	.1637	.1791	.1916
0.02	.1681	.1809	.1912

The author summarized his results with dilute solutions in the formula:

$$n_t = 0.1788 + 0.0011(t - 20)$$

1905. **R. Luther und B. Krsnjavi.**

Ueber komplexe Verbindungen der Kohlensäure mit Schwermetallen. Zeit. anorg. Chem., *46*, 170.

Solutions of cupric (sulphate), ferric, or uranyl salts in excess of alkali bicarbonate solution were placed in the bottom of a U-tube, both branches of which were filled with potassium bicarbonate solution; on passing through an electric current the colored zone moved toward the anode (slowly, at least in the case of the cupric compound). Taken in conjunction with the observation that these bodies diffuse through parchment, this shows the presence of the metals in the complex anions.

1905. **C. Tubandt.**

Ueber die alkalischen Kobaltoxydullösungen. Zeit. anorg. Chem., *45*, 368.

The blue solution obtained by dissolving cobaltous hydroxide in concentrated potash or by the electrolysis of strong potash with a cobalt anode contains the cobalt (or hydroxide) only as colloid, for it does not dialyse through parchment into concentrated potash; when a current of 0.1 ampere was passed through the solution placed in the lower half of a U-tube both arms being filled with potash solution the blue layer did not move perceptibly in several hours; in 36 hours all the cobalt was precipitated, mostly as metal on the cathode, some as oxide in the anode compartment, none on the anode. Addition of glycerine has no influence on any of these phenomena.

1906. **H. Jahn's Pupils.**

For the following series I am indebted to the courtesy of Professor Jahn, who voluntarily sent me his own copies of the dissertations, as they are out of print. He expects to publish them together in the Zeit. phys. Chem. in the course of the present winter.

Apparatus and method the same as in the 1901 series; capacity of anode compartment 300–800 c.c.; anode Cd or Zn, cathode Hg covered with a concentrated solution of $CdSO_4$ or sometimes $ZnCl_2$.

E. Berliner.

Dissert., 1902.

Ag anode, cathode Hg covered with $Cu(NO_3)_2$.

The paper further contains measurements of the transport in mixtures of $AgNO_3$ and KNO_3 showing that the mobility of the Ag ion is not appreciably affected by the presence of the potassium nitrate.

$AgNO_3$	0.498m	18°	0.8g Ag	0.00–0.09 %	3ex	a.516 ± 5
	0.249	18°	0.5	0.02–0.1	3	a.519 ± 5
	0.124	18°	0.5	0.00–0.1	3	a.526 ± 1
	0.068–0.0166	18°	0.4	0.02–0.5	7	a.528 ± 3
	0.0111–0.0047	18°	0.1–0.4	0.00–0.1	7	a.531 ± 5
	0.5–0.007	30°	0.3–0.7	0.01–0.2	27	a.519 ± 7

A. Eisenstein.

Dissert., 1902, quoted by Roth, Zeit. phys. Chem., *42*, 210. 1903.

The middle layer of solution never showed the least trace of

zinc — from anode or cathode; the change in composition is therefore ascribed to evaporation of the ethyl alcohol.

NaCl

0.034m	18°	0.3g Ag	0.07–0.15 %	3ex	a.599 ± 2	10 vol. % alcohol
0.017–0.009	18	0.2–0.3	0.05–0.3	9	a.594 ± 3	10 " " "
0.033	18	0.6	0.3 –0.4	3	a.592 ± 0	20 " " "
0.017–0.011	18	0.25	0.1 –0.4	7	a.588 ± 2	20 " " "
0.0084	18	0.23	0.1 –0.3	3	a.586 ± 1	20 " " "
0.033–0.011	18	0.2–0.5	0.0 –0.3	9	a.584 ± 3	25 " " "
0.033–0.011	18	0.2–0.7	0.1 –0.4	11	a.578 ± 5	30 " " "
0.033	18	0.3	0.1 –0.15	2	a.578 ± 2	40 " " "
0.017	18	0.23	0.1 –0.3	4	a.575 ± 3	40 " " "
0.011	18	0.2	0.3 –0.4	3	a.573 ± 1	40 " " "

S. Goldlust.

Dissert., 1902.

K_2SO_4	0.0333m	18°	0.6g Ag	0.02–0.04 %	3ex	a.512 ± 1
	0.0167	18	0.4	0.01–0.05	4	a.510 ± 2
	0.0089–0.004	18	0.13–0.35	0.03–0.15	9	a.516 ± 2
Na_2SO_4	0.0332m	18°	0.3–0.6g Ag	0.01–0.12 %	4ex	a.621 ± 2
	0.0167	18	0.4	0.13–0.16	3	a.613 ± 1
	0.008–0.004	18	0.3	0.01–0.2	9	a.609 ± 2
$CdSO_4$	0.0333m	18°	0.3–0.4g Ag	0.01–0.04 %	3ex	a.631 ± 2
	0.0167	18	0.4	0.09	3	a.619 ± 2
	0.0084–0.0042	18	0.23–0.37	0.02–0.12	9	a.613 ± 1

A. Hertz.

Dissert., 1904.

KCl	0.2–0.05m	18°	0.4 –0.7g Ag	0.2 –0.03 %	9ex	a.506 ± 4
	0.2–0.03	30°	0.14–0.8	0.05	12	a.502 ± 3
	0.02–0.007	30°	0.1	0.1 –0.01	12	a.501 ± 1
	0.2–0.03	0°	0.14–0.6	0.1 –0.00	12	a.509 ± 2
	0.017	0°	0.15	0.03	3	a.507 ± 2
	0.011–0.0086	0°	0.1	0.07–0.01	6	a.506 ± 2
	0.0067	0°	0.1	0.1 –0.01	3	a.505 ± 0
NH_4Cl	0.034m	0°	0.13g Ag	0.04–0.01	3ex	a.513 ± 1
	0.017	0°	0.12	0.04–0.00	3	a.511 ± 2
	0.011–0.0084	0°	0.12	0.1 –0.00	6	a.510 ± 1

M. Huybrechts.

Dissert., 1902.

$MgSO_4$	0.0339m	18°	0.3 –0.5g Ag	0.01–0.02 %	3ex	a.631 ± 1
	0.0172	18°	0.3	0.00–0.04	3	a.624 ± 2
	0.0085	18°	0.26	0.01–0.10	3	a.619 ± 1
	0.006–0.0034	18°	0.22	0.03–0.09	9	a.614 ± 2
	0.0339	30°	0.3 –0.8	0.01–0.03	3	a.624 ± 2
	0.0168	30°	0.4	0.01	3	a.616 ± 2
	0.0083–0.006	30°	0.3	0.03–0.05	6	a.613 ± 1

H_2SO_4	0.124m	18°	1.1g Ag	0.02–0.05	3ex	a.168 ± 3
	0.062–0.0055	18°	0.3 –0.9	0.00–0.06	14	a.176 ± 4
	0.0052	18°	0.17	0.00–0.02	3	a.173 ± 1
	0.00465	18°	0.12	0.00–0.06	3	a.157 ± 3
	0.00499	18°	0.12	0.00–0.10	3	a.155 ± 4
	0.0309	30°	0.4 –0.6	0.01–0.05	3	a.195 ± 4
	0.0176	30°	0.4 –0.5	0.01–0.03	3	a.188 ± 1
	0.0085	30°	0.3 –0.5	0.00–0.07	3	a.186 ± 2
	0.00600	30°	0.25	0.02–0.04	3	a.184 ± 0
	0.00484	30°	0.12	0.04–0.09	3	a.170 ± 2
	0.00464	30°	0.13	0.12	1	a.161
	0.00404	30°	0.17	0.02–0.05	3	a.162 ± 3

Joachim.

Dissert., as yet unpublished.

HCl	0.0321m	18°	a.165
	0.0166	18°	a.167
	0.0112	18°	a.166
	0.0083	18°	a.167
	0.0066	18°	a.168

H. Schultz.

Dissert., 1904.

I think that the author would have been justified in calculating his results to the fourth decimal place.

NaCl	0.118m	0°	0.3–0.5g Ag	0.00–0.07%	3ex	a.615 ± 1
	0.073	0°	0.3	0.00–0.04	3	a.614 ± 1
	0.034–0.012	0°	0.13–0.2	0.00–0.04	9	a.613 ± 1
	0.0085–0.0067	0°	0.1	0.01–0.03	6	a.612 ± 0
	0.118–0.072	18°	0.3–0.5	0.00–0.03	6	a.605 ± 1
	0.119–0.031	30°	0.1–0.45	0.00–0.03	9	a.597 ± 1
	0.016–0.010	30°	0.11–0.19	0.00–0.02	6	a.596 ± 1
	0.0086–0.0067	30°	0.11	0.00–0.03	6	a.595 ± 0
NH_4Cl	0.034m	18°	0.24g Ag	0.01–0.06	3ex	a.510 ± 0.5
	0.017	18°	0.22	0.00–0.01	3	a.509 ± 0.5
	0.012	18°	0.16	0.00–0.02	3	a.508 ± 0.5
	0.0083	18°	0.15	0.02–0.06	3	a.507 ± 0.5
	0.034	30°	0.2–0.3	0.00–0.05	3	a.506 ± 0.5
	0.017	30°	0.14–0.2	0.00–0.02	3	a.505 ± 0.0
	0.012	30°	0.13	0.00–0.04	3	a.505 ± 0.5
	0.0083	30°	0.1–0.14	0.00–0.01	3	a.504 ± 0.0

E. Wolff.

Dissert., 1903.

HCl	0.1202m	0°	0.6–1.2g Ag	0.01–0.14%	3ex	a.167 ± 2
	0.0640	0°	0.5–0.7	0.02	3	a.161 ± 2
	0.0318	0°	0.4–0.6	0.02	3	a.160 ± 1
	0.0160	0°	0.2	0.02–0.04	3	a.155 ± 1
	0.0106–0.0064	0°	0.2	0.01–0.2	9	a.154 ± 3
	0.12–0.006	30°	0.2–1.0	0.00–0.2	21	a.183 ± 4

$BaCl_2$	0.0165m	0°	0.22g Ag	0.02–0.18	3ex	a.573 ± 2
	0.0084	0°	0.16	0.03–0.05	3	a.566 ± 1
	0.0056–0.0034	0°	0.08–0.15	0.00–0.2	9	a.562 ± 2
	0.016–0.008	30°	0.24–0.4	0.02–0.12	6	a.557 ± 2
	0.005–0.003	30°	0.2	0.00–0.2	9	a.555 ± 2

INDEX OF CHEMICALS.

In the following alphabetical list, each substance is given under the symbol of its cation or metal and is followed by the names of the experimenters who have worked with it, together with the dates of the papers; this facilitates reference to the chronological compilation of the data. In addition, anions are given; these are followed by a list of the cations of the combinations which have been experimented with. Thus after "SO_4" are found the metals whose sulphates have been studied, and to which the reader is referred for the names of the experimenters. The papers in brackets are those in which the chemicals used were merely incidental, or in which the experiments were only qualitative.

$AgBr+Hg(NO_3)_2$ (Morse, 1902)

$AgC_2H_3O_2$ Hittorf, 1853; Loeb and Nernst, 1888; Mather, 1897; Bein, 1898; Hoffmeister, 1898

$Ag(C_2H_5)SO_4$ Loeb and Nernst, 1888

$Ag(C_6H_5)SO_3$ Loeb and Nernst, 1888

$Ag(C_9H_{11})SO_3$ Loeb and Nernst, 1888

$Ag(C_{10}H_7)SO_3$ Loeb and Nernst, 1888

AgCN.KCN Hittorf, 1859 (Noyes and Blanchard, 1901)

$AgCl+Hg(NO_3)_2$ (Morse, 1902)

$AgClO_3$ Loeb and Nernst, 1888; Carrara, 1903

$AgClO_4$ Loeb and Nernst, 1888

$Ag_3Cr(C_2O_4)_3$ Kistiakowsky, 1890, 1901

AgI+KI Rieger, 1901

$AgI+Hg(NO_3)_2$ (Morse, 1902)

$Ag_3I(NO_3)_2$ (Hellwig, 1900)

$AgNO_3$ Hittorf, 1853; Wiedemann, 1856; (Lodge, 1886); Nernst and Loeb, 1888; Kistiakowski, 1890; (Chassy, 1890); Bein, 1892; Campetti, 1894; (Whetham, 1895); Mather, 1897; Bein, 1898; Hoffmeister, 1898; Berliner, 1901; Steele, 1902; Schlundt, 1902; Carrara, 1903; Jones and Bassett, 1904; Dempwolff, 1904; Franklin and Cady, 1904; Berliner, 1906

$Ag_2S_2O_6$ Loeb and Nernst, 1888

Ag_2SO_4 Hittorf, 1853; (Chassy, 1890)

Ag_2SiFl_6 Loeb and Nernst, 1888

$AlCl_3$ Hittorf, 1859

$Al_2O_3.K_2O.4C_2O_3.7\frac{1}{2}H_2O$ Rosenheim, 1896

$Al_2O_3.3K_2O.6C_2O_3.5H_2O$ Rosenheim, 1896

$Al_2(SO_4)_3.K_2SO_4.24H_2O$ (Daniell and Miller, 1844)

$Al_2(SO_4)_3$ (Daniell and Miller, 1844)

AsO_3...K

AsO_4...K

$AuCl_3.KCl$ Hittorf, 1859

$AuCl_3O.H_2$ Hittorf and Salkowski, 1899 (Pouillet, 1845)

$BaCl_2$ Weiske, 1857; Hittorf, 1859; (Lodge, 1886); (Chassy, 1890); Bein, 1892; (Whetham, 1895); Des Coudres, 1896; Hopfgartner, 1898; Bein, 1898; Noyes, 1901; Bukschnewski, 1901; Steele, 1902; Hittorf, 1902; Wolff, 1906

$Ba(NO_2)_2$ Vogel, 1903
$Ba(NO_3)_2$ Daniell and Miller, 1844; (Chassy, 1890); Noyes, 1901; Hittorf, 1859
$Ba(OH_2)$ Daniell, 1840
BrO_3...K
Br...Na-Cd-H-K-Zn-AgHg-Li
CH_3ONa Dempwolff, 1904
$C_2H_3O_2$...H-Ag-Cd-Cu-Fe-Li-Na-K-UO_2-Zn
$C_2H_5.SO_4$...Ag-K
$C_3H_5O_2$ (propionate)...H-UO_2
$C_4H_4O_4$ (succinate)...H
$C_4H_4O_6$ (tartrate)...KNa-(Fehling's solution)-UO_2
$C_6H_5.OH.NO_2$ (ortho-nitro-phenol) (Riesenfeld, 1901)
$C_6H_5.SO_3$...Ag
$C_9H_{11}.SO_3$...Ag
$C_{10}H_7.SO_3$...Ag
$C_{17}H_{19}NO_3.HCl$ (morphine) Hittorf, 1859
$C_{22}H_{22}N_2O_2.HCl$(strychnine) Hittorf, 1859
CN...Ag.K-Cd-Hg-K-Zn-K.Cd-KFe-HFe-KHg-KZn
CNS...K-Fe
C_2O_4...H-Ag-Cr.Ag_3-K.Fe-K-NH_4
$C_2O_3.K_2O.WO_3.H_2O$ Rosenheim, 1896
$4C_2O_3.K_2O.Al_2O_3.7\frac{1}{2}H_2O$ Rosenheim, 1896
$2C_2O_3.2MO_3.3H_2O.(NH_4)_2O$ Rosenheim, 1896
$2C_2O_3.(NH_4)_2O.2MO_3.3H_2O$ Rosenheim, 1896
$4C_2O_3.3(NH_4)_2O.V_2O_5.4H_2O$ Rosenheim, 1896
$6C_2O_3.5H_2O.3K_2O.Al_2O_3$ Rosenheim, 1896
$6C_2O_3.3K_2O.Cr_2O_3.6H_2O$ Rosenheim, 1896
$C_2O_3.MO_3.3H_2O$ Rosenheim, 1896
CO_3...K-Li-Na-Cu-Fe-UO_2
$CaCl_2$ Weiske, 1857; Hittorf, 1859; (Chassy, 1890); (Whetham, 1892); Bein, 1892; (Whetham, 1895); Bein, 1898; Bein, 1899; Steele and Denison, 1902; Steele, 1902; Hittorf, 1902; Denison, 1903
CaI_2 Hittorf, 1859
$Ca(NO_3)_2$ Hittorf, 1859; (Whetham, 1892); Steele and Denison, 1902
$Ca(OH)_2$ Bein, 1898
$CaSO_4$ Daniell and Miller, 1844; Steele and Denison, 1902
$CdBr_2$ Gordon, 1897; Kümmell, 1898; Goldhaber, 1901; Bukschnewski, 1901
$Cd(C_2H_3O_2)_2$ Carrara, 1903
$Cd(ClO_3)_2$ Carrara, 1903
$CdCl_2$ Hittorf, 1859; Bein, 1892; Des Coudres, 1896; Bein, 1898; Kümmell, 1898; Bein, 1899; Goldhaber, 1901; Bukschnewski, 1901; Hittorf, 1902; Carrara, 1903
$Cd(CN)_2 + KCN$ Rieger, 1901
CdI_2 Hittorf, 1859; Lenz, 1882; Bein, 1892; Gordon, 1897; Kümmell, 1898; Redlich, 1901; Bukschnewski, 1901; Hittorf, 1902; Carrara, 1903
$CdI_2 + KI$ Hittorf, 1859
$Cd(NO_3)_2$ Carrara, 1903
$CdSO_4$ Weber, 1889; (Chassy, 1890); Gordon, 1897; Kümmell, 1898; Steele, 1901; Redlich, 1901; Goldlust, 1906
Cl Ag.Hg-Al-Au-Ba-$C_{17}H_{19}NO_3$.H-$C_{22}H_{22}N_2O_2$.H-Ca-Cd-Co-Co.Ca-Co.Ca.Zn-Co.H-Co.Hg-Co.Mg-Co.NH_3-Cs-Cu-CuH-Fe-Fe.H-H-H.Pt-K-K.Au-K.Cd-K.Hg-Li-Mg-Mn-Na-Na.Pt-NH_4-Pt-Rb-RuK_2NO-Sn-Sr-Tl-UO_2-Zn
ClO_3...Ag-Cd-Cu-K-Li
ClO_4...Ag-K
Co (purpureocobaltchloride, praseo bisulphate, diamine-cobalt-potassium nitrite, chlor-purpureo-cobalt nitrate) (Kremann, 1903)
$CoCl_2 + HCl$ (Donnan and Bassett, 1902)
$CoCl_2 + MgCl_2$ (Donnan and Bassett, 1902)
$CoCl_2 + CaCl_2$ (Donnan and Bassett, 1902)
$CoCl_2 + CaCl_2 + ZnCl_2$ (Donnan and Bassett, 1902)
$CoCl_2 + HgCl_2$ (Donnan and Bassett, 1902)

$Co(CN)_6$...K
$Co(OH)_2 + KOH$ (Tubandt, 1905)
$CoPO_3$...Na
$CoCl_2$ Pouillet, 1845; (Whetham, 1892); Bein, 1898; (Donnan and Bassett, 1902)
$Co(NO_3)_2$ (Chassy, 1890); (Whetham, 1892)
$CrAg_3(C_2O_4)_3$ Kistiakowsky, 1890, 1901
$Cr_2O_3.3K_2O.6C_2O_3.6H_2O$ Rosenheim, 1896
CrO_2...K
CrO_4...K-Cu-H
Cr_2O_7.. K-H
$Cr_2(SO_4)_3$ Bonnet and Richards, 1904
CsCl Bein, 1898
$Cu(C_2H_3O_2)_2$ Carrara, 1903
$CuCl_2$ (Chassy, 1890); (Whetham, 1892); (Lussana, 1894); Bein, 1898; (Masson, 1898); (Noyes and Blanchard, 1901); Carrara, 1903; Bridges, 1904; Kohlschütter, 1904
$CuCl_2 + HCl$ (Donnan and Bassett, 1902)
$Cu(ClO_3)_2$ Carrara, 1903
$CuCO_3$ (Luther and Krsnjavi, 1905)
$CuCrO_4$ (Noyes and Blanchard, 1901)
$Cu(NO_3)_2$ Wiedemann, 1856; (Chassy, 1890); Carrara, 1903
$CuPO_3$...Na
$CuSO_4$ (Daniell and Miller, 1844); Hittorf, 1853, 1856; Wiedemann, 1856; Kirmis, 1878; Lenz, 1882; (Lodge, 1886); Weber, 1889; (Chassy, 1890); Bein, 1892; Lussana, 1893; Sheldon and Downing, 1893; (Lussana, 1894); Gordon, 1897; (Küster, 1897); Schrader, 1897; Bein, 1898; Hopfgartner, 1898; Masson, 1898; (Masson and Setele, 1899); Metelka, 1901; Rieger, 1901; (Steele, 1901); Hittorf, 1902; Steele, 1902; Carrara, 1903
$CuSO_4.K_2SO_4$ (Daniell and Miller, 1844); Rieger, 1901
$CuSO_4 + NH_4OH$ (Donnan and Bassett, 1902
Di-methyl-pyrone (Coehn, 1902)
$Fe(C_2H_3O_2)_2$ (Whetham, 1894)
$Fe(CNS)_3$ (Riesenfeld, 1901)
$Fe(CN)_6$...H-K
$FeC_2O_4.K_2C_2O_4$ Rieger, 1901
$Fe(C_2O_4)_3$...K
$Fe_2(CO_3)_2$ (Luther und Krsnjavi, 1905)
$FeCl_3$ (Pouillet, 1845); Hittorf, 1859; (Whetham, 1894)
$FeCl_3 + HCl$ (Donnan and Bassett, 1902)
$FeFl_3.3NaFl$ (Peters, 1898)
Fehling's solution (Küster, 1897); (Masson and Steele, 1899); (Donnan and Bassett, 1902)
$FeSO_4$ (Lussana, 1894)
$Fe_2(SO_4)_3$ (Daniell and Miller, 1844); Peters, 1898
Fl...FeNa
H_2AuCl_3O Hittorf and Salkowski, 1899
HBr Hittorf, 1859; McIntosh, 1898
$H.C_2H_3O_2$ (Lodge, 1886); Schrader, 1897; Hoffmeister, 1898; McBain, 1903
$H.C_3H_5O_2$ McBain, 1903
$H_2.C_2O_4$ (Oxalic acid); (Bourgoin, 1870); Bein, 1898; McIntosh, 1898
$H_2.C_4H_4O_4$ (Succinic acid); Bourgoin, 1868; Bein, 1898
HCl Hittorf, 1859; (Lodge, 1886); Cattaneo, 1896; Des Coudres, 1896; Hopfgartner, 1898; McIntosh, 1898; Bein, 1898, 1899; Bogdan, 1901; Noyes and Sammet, 1902; Joachim, 1906; Wolff, 1906
H_2CrO_4 (Charpentier, 1903)
$H_4Fe(CN)_6$ (Porrett, 1814)
$HgBr_2 + Hg(NO_3)_2$ (Morse, 1902)
$HgCl_2 + KCl$ Hittorf, 1859
$HgCl_2 + Hg(NO_3)_2$ (Morse, 1902)
$Hg(CN)_2.2KCN$ Rieger, 1901
$HgI_2 + KI$ Rieger, 1901
$HgI_2 + Hg(NO_3)_2$ (Morse, 1902)
$Hg(NO_3)_2 + AgCl$, $HgCl_2$, AgBr, $HgBr_2$, AgI, or HgI_2 (Morse, 1902)
HI Hittorf, 1859; McIntosh, 1898
HIO_3 Hittorf, 1859
NOH_3 Wiedeman, 1856; Bourgoin, 1868; Bein, 1898; Hoffmeister, 1898; Bukschnewski, 1901
$H_2O_2 \cdot NaOH$ (Calvert, 1901)

$H_2.PtCl_4O$ Hittorf and Salkowski, 1899; Dittenberger and Dietz, 1899
H_2PtCl_5 Dittenberger and Dietz, 1899
H_3PO_4 Daniell, 1840
H_2SO_4 Faraday, 1833; Daniell, 1839, 1840; Wiedemann, 1856; Hittorf, 1859; Bourgoin, 1868; (Lodge, 1886); Schrader, 1897; McIntosh, 1898; Bein, 1898; Stark, 1899; Kendrick, 1900; Tower, 1904; Huybrechts, 1906
I...Ag-Ag.Hg-Ca-Cd-H-K-K.Cd-K.Hg-Li-Mg-Na-N$(C_2H_5)_4$-S$(CH_3)_3$-Zn
I_3...K
IO_3...H
K_3AsO_3 (Daniell and Miller, 1844)
K_3AsO_4 (Daniell and Miller, 1844)
KBr Hittorf, 1856; (Lodge, 1886); Bogdan, 1901; Steele, 1901, 1902; Riesenfeld, 1902; Denison, 1903; Dempwolff, 1904
$KBrO_3$ Steele, 1902
$KC_2H_3O_2$ Hittorf, 1856; Hittorf, 1856, 1858
$K(C_2H_5)SO_4$ Hittorf, 1859
KCN (Daniell and Miller, 1844); Hittorf, 1859; Rieger, 1901
KCN.AgCN Hittorf, 1859; (Noyes and Blanchard, 1901)
$KCN+Hg(CN)_2$ Rieger, 1901
$KCN+Zn(CN)_2$ Rieger, 1901
KCNS (Daniell and Miller, 1844)
K_2CO_3 Kuschel, 1881; (Whetham, 1892); (Whetham, 1894); Bein, 1898
$K_2C_2O_4$ Hittorf, 1859; (Whetham, 1892); Aletter, 1904
$K_2C_2O_4.FeC_2O_4$ Rieger, 1901
KCl Hittorf, 1856; Weiske, 1857; Hittorf, 1858; Kuschel, 1881; (Chassy, 1890); Bein, 1892; (Whetham, 1892); (Lussana, 1894); Des Coudres, 1896; Schrader, 1897; Bein, 1898; Masson, 1898; Hopfgartner, 1898; Bogdan, 1901; Steele, 1901; Abegg and Gaus, 1902; Hittorf, 1902; Riesenfeld, 1902; Steele, 1902; Steele and Denison, 1902; Denison, 1903; Dempwolff, 1904; Hertz, 1906
$KCl.AuCl_3$ Hittorf, 1859
$KCl.HgCl_2$ Hittorf, 1859
$KCl.2HgCl_2$ Hittorf, 1859
$KCl.4HgCl_2$ Hittorf, 1859
$KClO_3$ Hittorf, 1859
$KClO_4$ Hittorf, 1859
$K_3Co(CN)_6$ Kistiakowsky, 1901
KCo (diamine-nitrite) (Kremann, 1903)
$K_2Cr_2O_7$ Hittorf, 1859; (Whetham, 1892, 1894); Riesenfeld, 1901; (Charpentier, 1903)
K_2CrO_4 (Daniell and Miller, 1844; Hittorf, 1859; Lenz, 1882; Masson, 1898; (Steele, 1901); Steele, 1902; Denison, 1903
$K.CrO_2$ (Kremann, 1903)
$K_3Fe(CN)_6$ (Daniell and Miller, 1844)
$K_4Fe(CN)_6$ (Porrett, 1814); (Daniell and Miller, 1844); Hittorf, 1859; (Lodge, 1886); Kistiakowsky, 1901
$K_3Fe(C_2O_4)_3$ Rieger, 1901; Steele, 1902
KH_2PO_4 Hittorf, 1859
KI Hittorf, 1856, 1858; Lenz, 1882; (Lodge, 1886); Schrader, 1897; Bein, 1898; Rieger, 1901; Nernst and Riesenfeld, 1901; Riesenfeld, 1902; Dempwolff, 1904
KI_3 (Steele, 1902); Burgess and Chapman, 1904
$KI+HgI_2$ Rieger, 1901
$KI.CdI_2$ Hittorf, 1859
$KMnO_4$ (Whetham, 1892); Nernst, 1897; Bein, 1898
$KNa.C_4H_4O_4$ (Küster, 1897)
KNO_3 Hittorf, 1856, 1858; (Chassy, 1890); (Nernst, 1897); Franklin and Cady, 1904
KNO_3+AgNO_3 Berliner, 1906
$3K_2O.Al_2O_3.6C_2O_3.5H_2O$ Rosenheim, 1896
$K_2O.Al_2O_3.4C_2O_3.7\frac{1}{2}H_2O$ Rosenheim, 1896
$3K_2O.Cr_2O_3.6C_2O_3.6H_2O$ Rosenheim, 1896
KOH Daniell, 1840; Wiedemann, 1856; Bourgoin, 1868; Kuschel, 1881; (Noyes and Blanchard, 1901); Steele, 1902
$KOH+Co(OH)_2$ (Tubandt, 1905)
$K_2O.WO_3.C_2O_3.H_2O$ Rosenheim, 1896

$K_2RuNOCl_5$ (Lind, 1903)
K_2SO_4 Daniell, 1840; (Daniell and Miller, 1844); Hittorf, 1856; (Chassy, 1890), Masson, 1898; Noyes, 1901; Goldlust, 1906
$K_2SO_4.Al_2(SO_4)_3 + 24H_2O$ (Daniell and Miller, 1844)
$K_2SO_4.CuSO_4$ (Daniell and Miller, 1844); Rieger, 1901
$K_2SO_4.MgSO_4$ (Daniell and Miller, 1844)
K_2ZnO_2 (Kremann, 1903)
LiBr Dempwolff, 1904
$Li.C_2H_3O_2$ Carrara, 1903
LiCl Kuschel, 1881; Campetti, 1894; Des Coudres, 1896; Bein, 1898; Masson, 1898; Bein, 1899; Goldhaber, 1901; (Steele, 1901); Steele, 1902; Riesenfeld, 1902; Denison, 1903; Dempwolff, 1904
$LiClO_3$ Carrara, 1903
Li_2CO_3 Kuschel, 1881
LiI Kuschel, 1881; Carrara, 1903
$LiNO_3$ Carrara, 1903
LiOH Kuschel, 1881
Li_2SO_4 Kuschel, 1881; Masson, 1898; Aletter, 1904
Methyl orange (Kremann, 1903)
$MgCl_2$ Hittorf, 1859; Bein, 1898; (Chassy, 1890); Steele, 1902
MgI_2 Hittorf, 1859
$Mg(NO_3)_2$ (Chassy, 1890)
$MgSO_4$ Hittorf, 1859; (Chassy, 1890); Bein, 1898; Hopfgartner, 1898; Masson, 1898; Steele, 1901, 1902; Denison, 1903; Huybrechts, 1906
$MgSO_4.K_2SO_4$ (Daniell and Miller, 1844)
$MnCl_2$ Pouillet, 1845; Hittorf, 1859; Bein, 1898
$MnO_4...K$
$MO_3.C_2O_3.3H_2O$ Rosenheim, 1896
$2MO_3.2C_2O_3.(NH_4)_2O.3H_2O$ Rosenheim, 1896
$2MO_3.C_2O_3.(NH_4)_2O$ Rosenheim, 1896
$2MO_3.(NH_4)_2O$ Rosenheim, 1896
Morphine hydrochloride Hittort, 1859
NaBr Bein, 1898; Bogdan, 1901; Oppenheimer, 1901; Steele, 1901, 1902; Denison, 1903
$NaCH_3O$ Dempwolff, 1904
$NaC_2H_3O_2$ Hittorf, 1859; (Chassy, 1890); (Whetham, 1894); (Steele, 1901); Abegg and Gaus, 1902
NaCl (Daniell and Miller, 1844); Wiedemann, 1856; Weiske, 1857; Hittorf, 1859; (Lodge, 1886); (Chassy, 1890); Bein, 1892; (Lussana, 1894); (Whetham, 1895); Cattaneo, 1896; Des Coudres, 1896; Bein, 1898; Hopfgartner, 1898; Masson, 1898; Bein, 1899; Bogdan, 1901; Steele, 1901, 1902; Abegg and Gaus, 1902; Denison, 1903; Franklin and Cady, 1904; Eisenstein, 1906; Schulz, 1906
Na_2CO_3 (Daniell and Miller, 1844); Kuschel, 1881; (Whetham, 1895); Bein, 1898
$Na.CoPO_3$ (Kremann, 1903)
$Na.CuPO_3$ (Kremann, 1903)
$3NaFl + FeFl_3$ (Peters, 1898)
Na_2HPO_4 Hittorf, 1859
NaH_2PO_4 (Daniell and Miller, 1844); Hittorf, 1859
NaI Hittorf, 1859; Dempwolff, 1904
$NaK.C_4H_4O_4$ (Küster, 1897)
$Na.NiPO_3$ (Kremann, 1903)
$NaNO_3$ Hittorf, 1859; (Chassy, 1890); (Whetham, 1895); Bein, 1898; Franklin and Cady, 1904
NaOH Wiedemann, 1856; Kuschel, 1881; (Lodge, 1886); Bein, 1898
Na_2PtCl_6 Hittorf, 1859
$Na_4P_2O_7$ Hittorf, 1859
$NaPO_3$ Hittorf, 1859; Wiesler, 1901
Na_3PO_4 Hittorf, 1859
Na_2SO_4 Hittorf, 1859; (Lodge, 1886); (Chassy, 1890); (Whetham, 1895); Masson, 1898; Goldlust, 1906
Na_2SO_3 (Daniell and Miller, 1844)
$Na_2S_2O_6$ (Daniell and Miller, 1844)
Na, UO_2 salts, see UO_2
$NaWO_4$ (Daniell and Miller, 1844)
$N(C_2H_5)_4.I$ Carrara, 1903
NH_4Cl (Daniell and Miller, 1844); Hittorf, 1856; (Whetham, 1892); Cattaneo, 1896; Bein, 1898; Masson, 1898; Hertz, 1906; Schultz, 1906
$(NH_4)_2C_2O_4$ (Daniell and Miller, 1844)

NH_4NO_3 Franklin and Cady, 1904
$(NH_4)_2O.2C_2O_3.2MO_3.3H_2O$ Rosenheim, 1896
NH_4OH Bein, 1898
$(NH_4)_2O.2MO_3$ Rosenheim, 1896
$(NH_4)_2O.2MO_3.C_2O_3$ Rosenheim, 1896
$(NH_4)_2SO_4$ (Lodge, 1886)
$(NH_4)_2SO_4.NiSO_4$ Pfanhauser, 1901
$3(NH_4)_2O.V_2O_5.4C_2O_3.4H_2O$ Rosenheim, 1896
$Ni(NO_3)_2$ (Chassy, 1890); Lussana, 1894
$NiPO_3$...Na
$NiSO_4$ (Chassy, 1890); (Lussana, 1894); Pfanhauser, 1901
$NiSO_4.(NH_4)_2SO_4$ Pfanhauser, 1901
NO_2...Ba-$KCoNH_3$
NO_3 ... Ag - AgI - Ba - Ca - Cd - Co - Co.NH_3-Cu - H - Hg - K - Li - Mg - Na-$NaUO_2$-NH_4-Ni-Pb-UO_2-Zn
$NOCl_5$...RuK_2
OH ... Ba-Ca-$C_6H_5NO_2$-K-K.Co - Li-Na-NH_4-Sr
$Pb(NO_3)_2$ (Chassy, 1890); (Whetham, 1892); Lussana, 1893
PO_4...H-KH_2-Na-NaH_2-Na_2H
PO_3...H_3-Na-Na_3
P_2O_7...Na_4
$PtCl_6$...H_2-Na_2
$PtCl_4O.H_2$ Dittenberger and Dietz, 1899; Hittorf and Salkowski, 1899
Pyrone (di-methyl) (Coehn, 1902)
RbCl Bein, 1898
RuK_2NOCl_5 (Lind, 1903)
$S(CH_3)_3.I$ Carrara, 1903
$SrCl_2$ Weiske, 1857; (Lodge, 1886); Bein, 1898; Steele, 1902; Denison, 1903
Seignette salt (Küster, 1897)
$SiFl_6$...Ag
$SnCl_4$ Hittorf, 1859; Dittenberger and Dietz, 1899
SO_3 ... $Ag(C_6H_5)$ - $Ag(C_{10}H_7)$ - $Ag(C_9H_{11})$-Na_2
SO_4...Ag-$Ag(C_2H_5)$-Al-Al.K-Ca-Cd-Co . NH_3 - Cr-Cu-Fe-H-K-KC_2H_5 - K . Cu-K.Mg-Li-Mg-NH_4-NH_4Ni - Na-Ni-Tl-UO_2-Zn
S_2O_6...Ag-Na
$Sr(OH)_2$ Daniell, 1840
Strychnine hydrochloride Hittorf, 1859
TlCl Bein, 1898
Tl_2SO_4 Bein, 1898
UO_2 (acetate, chloride, citrate, glycolate, lactate, nitrate, oxalate, propionate, salicylate, sulphate, tartrate) with and without the sodium salts (Kremann, 1903)
UO_2Cl_2 Hittorf, 1859
$UO_2.CO_3$ (Luther und Krsnjavi, 1905)
$V_2O_5.3(NH_4)_2O.4C_2O_3.4H_2O$ Rosenheim, 1896
WO_4-Na
$WO_3.C_2O_3.K_2O.H_2O$ Rosenheim, 1896
Zn acetate (Chassy, 1890)
$ZnBr_2$ Kümmell, 1898
$ZnCl_2$ Moser, 1855; Hittorf, 1859; (Chassy, 1890); Kümmell, 1898; Hittorf, 1902
$Zn(CN)_2 + KCN$ Reiger, 1901
ZnI_2 Kümmell, 1898; Hittorf, 1859
$Zn(NO_3)_2$ (Chassy, 1890); Weber, 1889
ZnO_2...K
$ZnSO_4$ (Daniell and Miller, 1844); Hittorf, 1859; Moser, 1885; (Chassy, 1890); Lussana, 1893; Kümmell, 1898; Gans, 1901; Straneo, 1903

INDEX OF AUTHORS.

In the following alphabetical list, the dates furnish reference to the chronological abstract.

Abegg, R., and Gaus, W., 1902
Abegg, R., and Steele, B. D.
Aletter, A., 1904
Bassett, H. P., and Jones, H. C., 1904
Bassett, H. B.,, Donnan, F. G., and Fox, C. J. J., 1902
Bein, W., 1892, 1896 (see A. Rosenheim), 1898, 1899
Berliner, E., 1901, 1906 (Jahn)
Bogdan, P., 1901 (Jahn)
Bonnet, F., and Richards, T. W., 1904
Bourgoin, E., 1870, 1868 and 1868
Bridges, J. S., 1904
Buksnewski, 1901 (Jahn)
Burgess, C. H., and Chapman, D. L., 1904
Cady, H. P., and Franklin, E. C., 1904
Campetti, A., 1894
Calvert, H. T., 1901
Carrara, G., 1903
Cattaneo, C., 1896
Chapman, D. L., and Burgess, C. H., 1904
Charpentier, A., 1903
Chassy, A., 1890
Coehn, A., 1902
Daniell, J. F., 1839
Daniell, J. F., 1840
Daniell, J. F., and Miller, W. A., 1844
Dempwolff, C., 1904
Denison, R. B., 1903
Denison, R. B., and Steele, B. D., 1902
DesCoudres, T., 1896
Dietz, R., and Dittenberger, W., 1899
Dittrich, C., 1899
Dittenberger, W., and Dietz, R., 1899
Donnan, F. G., Bassett, H., and Fox, C. J. J., 1902
Downing, G. M., and Sheldon, S., 1893
Eisenstein, A., 1906 (Jahn)
Faraday, M., 1833
Fox, C. J. J., Donnan, F. G., and Bassett, H. B., 1902
Franklin, E. C., and Cady, H. P., 1904
Gans, R., 1901
Gaus, W., and Abegg, R., 1902
Goldlust, S., 1906 (Jahn)
Goldberger, 1903
Goldhaber, 1901 (Jahn)
Gordon, V., 1897
Hellwig, K., 1900
Herz, A., 1906 (Jahn)
Hittorf, W., 1853, 1856, 1858, 1859. 1902
Hittorf, W., and Salkowski, H., 1899
Hoffmeister, H., 1898
Hopfgartner, K., 1898
Hornbostel, 1903
Huybrechts, M., 1906 (Jahn)
H. Jahn's pupils, 1901, 1906
Joachim, 1906 (Jahn)
Jones, H. C., and Bassett, H. P., 1904
Kendrick, A., 1900
Kirmis, M., 1878
Kistiakowsky, W., 1890, 1901
Kohlschütter, V., 1904
Krsnjavi, B., and Luther, R., 1905
Kremann, R., 1903
Kümmell, G., 1898
Kuschel, J., 1881
Küster, F. W., 1897
Lenz, R., 1882
Lind, S. C., 1903
Lodge, O., 1886
Loeb, M., and Nernst, W., 1888
Lussana, S., 1893, 1894
Luther, R., and Krsnjavi, B., 1905
Masson, O., and Steele, B. D., 1899
Masson, O., 1899
Mather, W. J., 1897
McBain, J. W., 1903
McIntosh, D., 1898
Metelka, 1901 (Jahn)

Miller, W. A., and Daniell, J. F., 1844
Morse, H., 1902
Moser, J., 1885
Mugdan, M., 1899, see Kendrick, 1900
Nernst, W., 1897
Nernst, W., and Loeb, M., 1888
Noyes, A. A., 1901
Noyes, A. A., and Sammet, G. V., 1902
Noyes, A. A., and Blanchard, A. A., 1901
Oppermann, E., and Garrard, C. C., 1900
Oppenheimer, 1906
Peters, R., 1898
Pfanhauser, W., 1901
Porrett, R., 1814
Pouillet, M., 1845
Redlich, B., 1901 (Jahn)
Richards, T. W., and Bonnet, F., 1904
Rieger, E., 1901
Riesenfeld, E. H., 1901, 1902
Rosenheim, A., 1896
Salkowski, H., and Hittorf, W., 1899
Sammet, G. V., and Noyes, A. A., 1902
Schlundt, H., 1902
Schrader, A., 1897
Schultz, H., 1906 (Jahn)
Sheldon, S., and Downing, G. M., 1893
Starck, W., 1899
Steele, B. D., 1901, 1902
Steele, B. D., and Abegg, R.
Steele, B. D., and Denison, R. B., 1902,
Steele, B. D., and Masson, O., 1899
Straneo, P., 1903
Tower, O. F., 1904
Tubandt, C., 1905
Vogel, F., 1903
Weber, C. L., 1889
Weiske, A., 1857
Whetham, W. C. D., 1892, 1894, 1895
Wiedemann, G., 1856
Wiesler, A., 1901
Wolff, E., 1906 (Jahn)

INDEX OF SOLVENTS OTHER THAN WATER.

All the references here given are also to be found in the general chemical and authors' indexes. There is only one paper on migration measurements of mixtures of fused electrolyes — Lorenz and Fausti, Zeit. f. Elektrochem. *10*, 630 (1904), it is not reviewed in the present abstracts; the migrations in mixtures of KCl, NaCl and $PbCl_2$ were investigated.

Acetonitrile.

Schlundt, 1902 — $AgNO_3$

Amyl Alcohol.

Hittorf, 1859 — CdI_2

Cattaneo, 1896 — HCl

Ethyl Alcohol.

Hittorf, 1853 — $AgNO_3$; 1859 — CdI_2, $ZnCl_2$, ZnI_2

Lenz, 1882 — CdI_2, KI, K_2CrO_4

Whetham, 1892 — $CaCl_2$, $Ca(NO_3)_2$, $CoCl_2$, $Co(NO_3)_2$

Campetti, 1894 — $AgNO_3$, LiCl

Cattaneo, 1896 — HCl

Mather, 1897 — $AgNO_3$

Bogdan, 1901 — KBr

Donnan and Bassett, 1902 — $CoCl_2$

Hornbostel, 1903 — KCl

Eisenstein, 1906 — NaCl

Goldberger, 1903 — $BaCl_2$

Ethyl Alcohol — Chloroform.

Cattaneo, 1896 — HCl

Ethyl Alcohol — Chloroform — Ether.

Cattaneo, 1896 — HCl

Glycerine.

Cattaneo, 1896 — HCl, NaCl, NH_4Cl

Methyl Alcohol.

Campetti, 1894 — $AgNO_3$, LiCl

Carrara, 1903 — $AgClO_3$, $AgNO_3$, $Cd(C_2H_3O_2)_2$, $CdCl_2$, $Cd(ClO_3)_2$, CdI_2, $Cd(NO_3)_2$, $Cu(C_2H_3O_2)_2$, $CuCl_2$, $Cu(ClO_3)_2$, $Cu(NO_3)_2$, $CuSO_4$, $LiC_2H_3O_2$, $LiClO_3$, LiI, $LiNO_3$, $N(C_2H_5)_4I$, $S(CH_3)_3I$

Dempwolff, 1904 — $AgNO_3$, KBr, KCl, KI, LiBr, LiCl, $NaCH_3O$, NaI

Jones and Bassett, 1904 — $AgNO_3$

Phenol.

Riesenfeld, 1901, 1902 — $Fe(CNS)_3$, KBr, KCl, KI, $K_2Cr_2O_7$, LiCl, orthonitrophenol.

Pyridine.

Schlundt, 1902 — $AgNO_3$

PROCEEDINGS

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. IX, PP. 79–158. PLATES I–XV. JULY 31, 1907.

DISTRIBUTION OF THE SUBCUTANEOUS VESSELS IN THE HEAD REGION OF THE GANOIDS, POLYODON AND LEPISOSTEUS.

BY WM. F. ALLEN.

(FROM THE STANFORD MARINE LABORATORY, PACIFIC GROVE, CALIF.)

CONTENTS.

PAGE.

I. *Introduction* 80
Material 80
Method of Procedure 80
History 82
II. *Distribution of the Subcutaneous Vessels in Polyodon* 94
1. Cephalic Sinuses and their Connections 94
Cephalic Lymphatic Trunk 96
Hyo-opercularis Sinus 98
Hyo-opercularis Lymphatic Trunk 98
Facial Lymphatic Trunks 100
2. Branchial Lymphatics (Nutrient Branchial Veins?) 101
Branchial Arch Lymphatics (Nutrient Veins?) 103
Respiratory and Nutrient Branchial Arteries 106
Dorsal and Ventral Endings of the Branchial Lymphatic Trunks (Nutrient Branchial Veins?) 108
Lymphoid Tissue Surrounding the Heart of Polyodon 108
III. *Distribution of the Subcutaneous Vessels in Lepisosteus* 113
Longitudinal Lymphatic Trunks 113
Pericardial Sinuses 114
Occipital Sinus 115
Branchial Lymphatic Sinuses 117
Hyo-opercularis Sinus 118
Cephalic Sinus 118
Branchial Lymphatic Trunks (Nutrient Veins?) 119
Inferior Jugular Vein 121
IV. *Deductions and Summary* 121
V. *Explanation of Plates* 126
VI. *List of Abbreviations Used in the Figures* 155

I. INTRODUCTION.

Material. — The Ganoids used for this problem consisted of *Polyodon spathula* (spoon-bill cat), *Lepisosteus tristœchus* (alligator gar), *Lepisosteus osseus* (spike-bill gar), and *Lepisosteus platostomus* (duck-bill gar), which are the most common Ganoids found on the mud bars and in the sloughs of the Ohio and Mississippi rivers about Cairo, Illinois. The fish were mostly taken through seining by moonlight; for it is at night that they leave the channels to do their feeding on the bars. *L. tristœchus* is by far the largest of the *Lepisosteidæ* and I at first hoped to use it as a type for the RHOMBOGANOIDEA, but found it necessary to give it up for the following reasons: *L. tristœchus* could only be obtained during the fall of the year. Other things being equal it was always able to force its way through the seine, and the large specimens were found too massive to inject and pickle conveniently. Consequently most of the injections and dissections were made on *L. osseus*, which differed from *L. platostomus* in no important detail, but which was found to be more suitable for these investigations.

Most of the dissections were made during what spare time I had, while engaged in somewhat similar work for Mr. E. P. Allis, Jr., at Cairo, Illinois, and the work was continued when called by him to the Stanford Marine Laboratory at Pacific Grove, California.

Method of Procedure. — As in my previous studies Hoyer's lead chromate gelatin mass and a Berlin blue gelatin mass were the injecting media used. Ordinarily the blood vessels were first injected with the blue mass, and the subcutaneous vessels were afterward filled with the yellow. Instead of making my own soluable blue as formerly, I found that what is sold by druggists as Tiernan's soluble Prussian blue was equally satisfactory and involved far less labor. Since all that is necessary is to add 200 c.c. of concentrated Prussian blue solution, preferably hot, to a hot solution of 25 gr. of gelatin that had been expanded in 100 c.c. of water.

In nearly every case the head was severed from the body a short distance behind the shoulder girdle, the intestine cut at the rectum, and the viscera pulled out with the head. With

Polyodon this was a very simple matter; while with the Lepisosteidæ which have such a bulwark of armor it was necessary first carefully to remove entirely two or three rows of scales a little back from the shoulder girdle. Great care should be exercised in this operation for the delicate longitudinal lymphatic trunks are very firmly attached to the scales by connective tissue. When this is completed the body can be severed as easily as *Polyodon*. Usually the blood vessels of *Polyodon* were first injected from the cut aorta, but with the Lepisosteidæ this was not deemed necessary. With the Lepisosteidæ the cut ends of the dorsal, ventral, and one of the lateral lymphatic trunks were first plugged with cotton, and the injection was made from the remaining lateral trunk. Since no dorsal and ventral lymphatic trunks were found in this region in *Polyodon* it was only necessary to stop up one of the lateral trunks and inject from the other. After the cephalic sinus and its posterior connections had been worked out in *Polyodon* it was found that a more satisfactory injection of the cephalic trunks could be obtained by injecting the so-called *cephalic lymphatic trunk*, forward, from a point designated by (*x*) in Fig. 1. During the summer months the heat was so intense at Cairo that the gelatin injecting mass in the vessels would not solidify unless the head was first placed in a bath of ice water. When once the mass was hard and the specimen placed in formalin it was found that no amount of summer temperature would liquefy it.

All the injected microscopic preparations were hardened in formalin, run up the alcohols, and mounted in xylol-balsam. The material for sectioning was fixed in Tellyesniczky's potassium bichromate-acetic mixture, imbedded in paraffin, cut 6 to 10 μ thick, stained in either Heidenhain's iron hæmatoxylin or Hansen's hæmatoxylin plus 2 per cent. glacial acetic acid,[1] and counterstained in a concentrated alcoholic solution of orange *G* plus a small per cent. of acid fuchsin.

[1] The object of adding the 2 per cent. glacial acetic to Hansen's solution was to do away with the precipitate which is always formed. The sections thus stained are red, but rapidly turn to a brilliant blue when placed in tap water that is alkaline. Formerly hæmalum was used for a simple hæmatoxylin stain, but my experience has been that the product as sold commercially varied so much that it could not be relied upon, and that Hansen's solution was superior to the strongest hæmalum.

History. — Since looking up the literature for my recent paper on the lymphatics of *Scorpænichthys*[1] several very interesting papers by Neuville,[2] Vialleton,[3] and Jossifoo[4] have been received.

Ever since the subcutaneous vessels have been studied there has been a merry war on as to whether they were lymphatics or veins, but so far as I am aware this controversy has been confined to the Selachians. No one to my knowledge has described these vessels in the Teleostomi as veins. In the Cyclostomi Müller (15,[5] p. 18) describes an abdominal lymphatic trunk in *Myxine* as running along beneath the chorda dorsalis, above the aorta. Throughout the body cavity it receives the intercostals and the visceral vessels. Anterior to the body cavity the trunk divides, each fork following the corresponding row of gills. No connection, however, with the venous system was established. Jackson, in his work on the circulation of *Bdellostoma*[6] (p. 35), observed a marked tendency for the injecting mass to escape from the blood vessels to the subdermal lymphatic spaces of the caudal region and the peri-branchial spaces about the gill pouches. Vialleton[7] (pp. 308–318), under the head of *espaces séreux interstitiels*, gives an extended and most interesting account of these peri-branchial spaces in *Petromyzon planeri* and *Ammocœtes*. It seems that the older writers, as Robin, Milne-Edwards, Nestler, Vogt and Yung, and Schneider, regarded these spaces as blood cavities on account of their connection with the interior jugular, and the fact that Schneider

[1] "Distribution of the Lymphatics in the Head, and in the Dorsal, Pectoral, and Ventral Fins of *Scorpænichthys marmoratus*." Proceedings of the Washington Academy of Sciences, VIII, 1906, pp. 41–90.

[2] H. Neuville, "Contribution à l'étude de la vascularisation intestinale chez les Cyclostomes et les Sélachiens." Annales des Sciences naturelles. 1901.

[3] L. Vialleton, "Les lymphatiques du tube digestif de la Torpille (Torpedo marmorata)." Archives d' anatomie microscopique. 1902.

[4] S. M. Jossifoo, "Sur les voies principales et les organes de propulsion de la lymphe chez certains Poissons." Arch. d'Anat. Micr. 1906.

[5] All bibliographical numbers in parentheses refer to a list of literature in a previous paper. See footnote 2.

[6] C. M. Jackson, "An Investigation of the Vascular System of *Bdellostoma dombeyi*." Bulletin of University of Cincinnati. No. 5. 1901.

[7] L. Vialleton, "Étude sur le cœur des lamproies." Archives d'anatomie microscopique. 1903.

found blood in these spaces is accounted for by Vialleton as being an entirely abnormal condition, which is brought about by a hemorrhage of the delicate branchial vessels into these cavities, as a result of excitement from capture. As to considering these spaces lymphatic cavities, Vialleton points out that they differ widely from other cavities designated by that name, and throws out a strong warning about the abuse of that term. Since the peri-branchial spaces are only developed in *Petromyzon* after metamorphosis, Vialleton pronounces these cavities to be a special apparatus adapted to the movements of the respiratory sacs. Neuville (*op. cit.*, p. 54), in opposition to the general opinion, holds that no separate chylous system is to be found in the digestive tract of the Cyclostomes. As a study in comparative anatomy I injected the blood vessels of the Pacific *Bdellostoma* (= *Polistotrema*) and found that the intercostal arteries alternated with the intercostal veins in supplying the septa between two myotomes, there being but one blood vessel for each septum, but for each septum there is an additional intercostal vessel that terminates in an abdominal sinus, which runs parallel with the aorta. This system we take to be lymphatic rather than a separate venous system. No attempt was made to determine how the injecting mass reached this system; whether it passed through venous-lymphatic openings or whether it broke through the delicate walls of the blood-vessels.

Robin (23, pp. 22–30) gives an excellent account of the early work of Monro and Fohmann on the lymphatics of the Selachians. The former, it seems (14), described the chylous vessels of the viscera fairly well, except that he portrayed the common visceral reservoir as continuing along the vena cava (cardinal) in order to empty into the sinus of Monro (precava or ductus Cuvieri); while according to Robin (p. 2) there are two triangular reservoirs, corresponding in position to the two cardinal sinuses, into which they are discharged. Lymphatics are indicated as coming from the pectoral fin, brain, eye, and ear, and the veine jugulaire antérieure (inferior jugular) is regarded as a lymphatic trunk. Monro confused the lateral line canal for a lymphatic trunk, and because he saw the injecting mass

pass out of the pores, concluded that this system also arose from free openings in the digestive tract. Robin states that Fohmann's work on *Torpedo marmorata* (4) contains nothing not found in Monro, and that his failure to inject the blood vessels has resulted in many incorrect relationships. Fohmann designates the common chylous reservoir as the *réservoir de Pecquet*, and finds in the digestive tract many connections between the small veins and the lymphatics. He has not found muscle fibers in these vessels, but considers them as contractile, and, contrary to Monro, claims that they do not possess valves save at the entrance into the veins.

Leydig (12) made a histological study of the lymphatics of the digestive tract of *Raja batis*, and reached the conclusion that the blood vessels are surrounded by chylous vessels. He was the first to describe the tubular bodies, *türbanliche Körper*, that encircle the lymphatic vessels, which Sappey and Mayer have so fully discussed.

Robin (23) after working up this system of vessels in *Torpedo galvanii* and other plagiostomes, firmly declares (pp. 2 and 32) that these subcutaneous vessels are veins, and that the chylous vessels are the only lymphatics possessed by a fish. He also describes (pp. 15–16) lymphatic networks arising from the heart and neighboring trunks, which reach the veins through the intermedian plexus on the œsophagus and liver.

Parker (20, pp. 720–1) describes these subcutaneous vessels in *Mustelus antarcticus* under the head of cutaneous veins, and states that so far as his experience goes that they invariably contain blood. A *dorsal cutaneous vein* is set forth as extending from the tail to some distance in front of the first dorsal fin. Behind the second dorsal it forks; the two branches encircling the fin unite in front in a single trunk, which when the first dorsal is reached subdivides into three branches, two of which encircle the fin to reunite in front while the median one passes ventrad to terminate in the left renal portal. An *anterior ventral cutaneous vein* extends from the pubis to the shoulder girdle. It is located between the skin and the abdominal muscles, and receives a beautiful plexus from the abdominal wall. "Anteriorly the vein trifurcates, the three

branches uniting again in the form of a rhomboid, the lateral angles of which are connected with the lateral veins." Posteriorly it bifurcates and both branches after following along the border of the pubic cartilage pass inward to unite with the iliac veins. The so-called *posterior ventral cutaneous vein* starts from the tail, and forming a loop around the anals, again unite in front of the fin to bifurcate in the cloaca region and empty into the cloaca veins. Parker notes a direct communication of the cloaca veins with the iliac, so that the anterior and posterior veins might be represented as a single trunk forming a loop around the anal fin and the cloaca. Finally the two *lateral cutaneous veins* are described and figured as running along the side of the trunk at the junction of the dorsal and ventral muscles. Posteriorly they unite with the caudal and dorsal cutaneous veins, and anteriorly they terminate in subscapular sinuses, which are discharged into corresponding cardinal sinuses.

Sappey (25) undoubtedly has done the most work of anyone on these subcutaneous vessels, and unquestionably pronounces them as lymphatics in the ray, dogfish (*Squalus*), and in several Teleosts. In these different groups he also takes up in detail the distribution of the blood vessels and the lateral line system. His monograph is illustrated by 12 large lithographic plates. In a ray he finds these subcutaneous vessels arising from the dorsal and ventral surfaces of the body, from the mucous canals, muscles, electrical apparatus, viscera and heart. Most of the lymphatics on the dorsal surface of the body are described and figured (Pl. 5, Fig. 1) as being in communication with the *grand sinus curviligne* (Fig. 1, 5) which lies above the gills, and near its posterior extremity communicates with the ductus of Cuvier from above. Three trunks have their origin from the anterior part of the pectoral fin and empty into this reservoir, which are designated from cephalad to caudad as *le tronc longitudinal* (Fig. 1, 2), *le tronc latéral antérieur*, and *le tronc latéral moyen*. Coming in from the rear or virtually continuous with the sinus curviligne is *le grand sinus longitudinal* (Fig. 1, 18). It extends caudad to the tail, and at the point of opening into the sinus curviligne it receives *le tronc lateral postérieur* (Fig.

1, 13), which drains the posterior part of the pectoral fin. At various intervals communicating branches are received from *le petit sinus longitudinal* (Fig. 1, 24), which runs parallel but median to the grand sinus. In the lumbar region there is a rich network (Fig. 1, 16), which in part empties into le grand sinus longitudinal and in part into its anterior branch le tronc lateral postérieur. Midway between the pectoral and ventral fins a large lateral branch is given off (Fig. 1, 23) to communicate with the veins at the articulation of the ventral fin, *les veines extrapelviennes*. This communicating trunk also receives the rich network from the ventral fin. Two lymphatic vessels are said to have their source from the snout region and flow toward the eye (Fig. 1, 1). The outer one passes behind the eye and empties into the internal jugular or a branch; while the inner one terminates in like manner mesad of the eye.

In brief, the subcutaneous vessels from the ventral surface of the body are set forth as follows: In the anterior part of the pectoral, laterad of the mouth, four vessels unite in a common trunk (Pl. VI, Fig. 1, 6), which passes dorsal to discharge itself into the anterior end of the sinus curviligne. Two of these vessels arise from the anterior part of the pectoral and are designated as *le tronc antérieur* (Fig. 1, 2) and *le tronc moyen* (Fig. 1, 9); while the other two come from the median portion of the body and are named *le tronc céphalique* (Fig. 1, 1) and *le tronc thoracique* (Fig. 1, 8). The former takes its origin from the snout region and the latter from the region immediately behind the mouth. *Le tronc postérieur* (Fig. 1, 15) collects the lymph from the posterior part of the pectoral and from the abdomen; it pierces the muscular wall to unite with the common vein of the pectoral fin. Sappey states that the abdominal plexus is remarkable for the fact that it not only anastomoses with the networks of the ventral and anal fins, but in addition there are numerous communications with the blood capillaries. The rich network of the anal unites in a great number of vessels that connect with those of the cloaca and intestine, and without a definite course disappear in the veins of the caudal fin.

According to Sappey the chylous vessels terminate in the ductus Curveri through a right and left trunk (Pl. VII, Fig. 5, 7), the openings being guarded by valves.

Sappey (p. 32) describes a lace-like lymphatic network arising from the heart, especially from the ventricle and bulbus, which is collected by two trunks (Pl. II, Fig. 3, 3) that terminate in the sinus of Curver. It should be noted that these two vessels correspond identically with what Parker (20, p. 720) describes and figures (Pl. 34, Fig. 4, Cor. V.) as the coronary veins.

In the rays Sappey finds numerous muscular bands encircling the lymphatics, not only of the viscera as described by Leydig, but also in all parts of the body. Aside from the digestive tract he figures them from the subcutaneous and intermuscular vessels of pectoral, from the abdominal and thoracic networks, and from the networks of the ventral fin and lumbar regions. When he first discovered them in 1870 he supposed that they were characteristic of the lymphatics of all fish, but later found them only in the rays. Sappey attributes a double rôle to these so-called lymphatic hearts, by contracting they would cause a peristaltic movement in these vessels, and to a certain extent would also take the place of valves.

After considering the lateral line system and the blood vessels of *Squalus* Sappey takes up (pp. 37–40 and Pl. X) the distribution of the lymphatic system. On each side of the body he finds two lateral lymphatic trunks, superior and inferior in position. The former (Fig. 3, 2) extends from the tail to the head, a little below the lateral line. In the tail region it forms a sort of fibrous sinus that empties into the caudal vein; while anteriorly it ends with the inferior trunk in a sinus or confluent (Fig. 1, 25), which opens into the precava, nèar its origin. The inferior lateral trunk (Fig. 3, 11) is a subcutaneous vessel, traversing in a median line from the tail to the head, where it blends with the superior trunk in forming a single vessel, which terminates in the cephalic sinus mentioned above. It should not be confounded with the corresponding vein, which is more profundus, being distinctly submuscular. Sappey states that the inferior trunk is sometimes absent. A median dorsal trunk

(Fig. 1, 15, and Fig. 3, 4), has its origin in the tail region. In passing cephalad it trifurcates when the dorsal fins are reached, the two outer branches receive the superficial networks and the median one the dorsal and ventral branches (Fig. 3, 8 and 9). In front of the fin these branches unite in a common trunk, which upon reaching the cranium bifurcates, each fork making a curve behind the eye to empty into the internal jugular. A median abdominal trunk extends from the ventral fin to the clavicle, where it bends to discharge itself into the sinus of Cuvier. Sometimes, according to Sappey, it bifurcates, and each fork terminates in the corresponding ductus of Cuvier. These six trunks are connected by a series of vessels into which a network of capillaries are discharged. A series of intercostals (Fig. 3, 13 and 14), connect the ventral with the inferior and superior trunks, and an irregular series, further apart, connect the dorsal with the two superior trunks. The chylous vessels as in the ray open into the ductus of Cuvier.

Sappey found lymphatic glands in the walls of the digestive tract and on the hearts of the ray, dogfish and sturgeon.

Mayer (18) in a most extensive monograph on the peculiarities of the organs of circulation in Selachians describes these subcutaneous vessels in *Squatina*, *Torpedo*, and *Raja* as veins. On pp. 339 and 340 he states that when a young *Scyllium canicula* is placed in an aquarium, that the *vena postica* of all the vertical fins are plainly visible. If the fish is excited the blood rapidly disappears from these veins, but returns again after a brief rest. With the ordinary swimming back and forth the blood is said to remain in the fins. Sometimes no fluid flowed out of the lateral vein after cutting it; consequently Mayer reasons because a trunk is bloodless it does not necessarily follow that it is a lymphatic vessel. According to Mayer (pp. 366–7 and 9) the subcutaneous veins do not carry pure blood, but rather a mixture of blood, a few small discs, many leucocytes, intermixed with a fluid resembling chyle; while the intestinal veins commonly contain blood, but at stated times chyle. Mayer has injected the sheaths surrounding the intestinal blood vessels and finds the chylous system of vessels as observed by Robin. On p. 368 he severely criticises Sappey for not being

able to let go of the idea that a fish must have a lymphatic system; while he himself is so impressed with the uselessness of such a system to a fish, that it almost appears to him as if it would be hateful in the eyes of the Lord for a fish to possess a lymphatic system. One might equally well apply the same line of reasoning to mammals.

With *Raja clavata* Mayer found the lymphatic hearts of Leydig and Sappey, or as he calls them *sphincters*, very abundant; while with their close relatives they were often absent. He also found them encircling arteries, and hence for these reasons was not willing to attribute the importance to them that Sappey did.

In the trunk region, in addition to the caudal vein and its intercostal branches, Mayer notes (pp. 316–337) not fewer than four longitudinal veins that have no counterpart in the arterial system. They are homologous to the dorsal, ventral, and lateral cutaneous veins of Parker and the corresponding lymphatic trunks of Sappey. In addition to the descriptions given these vessels by these authors, Mayer finds that the laterals not only terminate cephalad in subscapular reservoirs that empty into the cardinal sinuses, but continue cephalad to the orbit, where they send off anastomosing cross branches that also unite with the dorsal vein. Caudad the dorsal vein empties into a lateral and they, at the origin of the tail, unite with the ventrals, which are here paired, and shortly bend dorsad to culminate in the caudal vein. The two forks of the dorsal that encircle the dorsal fins are designated by Mayer as *venæ circulares*, which are said to receive two large branches from each fin. One or two *vena postica* come from the posterior part of the fin, and a *vena profunda* arises from the musculature of the fin. They unite in a small reservoir at the base of the fin, which communicates with the vena circularis. All of the orifices in the reservoir are said to be guarded by valves. Also all of the venous openings into the caudal vein are likewise protected by valves. Certain blood cavities were found in the hæmal canal, which may correspond to the hæmal lymphatic trunk of the bony fishes.

Neuville (*op. cit.*) studied in detail the blood vascular supply of the viscera in *Petromyzon marinus* and in numerous Selachians.

In the beginning of his paper he gives a most complete historical sketch of all the work done on the circulatory and lymphatic systems of fishes, and contends that all the vessels found in the digestive tracts of the Cyclostomes and Selachians are either arteries or veins and that a separate chylous system does not exist. He, however, finds a double venous system on the digestive tract of *Acanthias vulgaris;* one of which is the portal system, and the other system, which is figured on p. 92, he recognizes as corresponding to the descriptions of the chylous system as given by Robin and the older authors. Nevertheless he considers them as veins for the following reasons: First, on p. 90, he has found the *sinus stomacal* (Cisterne de Pecquet of Fohmann) to be full of blood. Second, on p. 94, he finds that upon injecting this system that the entire portal system is immediately filled. According to Neuville the system of absorption is entirely carried on by the veins in these groups, and with the Cyclostomes he finds the arrangement of the veins less complex than in the Selachians, which is in accord with their less complicated digestive tract.

A year later Vialleton (*op. cit.*) takes up the same problem from the standpoint of the digestive tract of *Torpedo*, and claims that Neuville was too hasty in his conclusions. In reply to the two objections raised by Neuville as to this system of vessels being veins rather than chylous, Vialleton says (p. 382) in answer to the first that it is not strange to find blood in a lymphatic trunk. As regards the second he states (p. 383) that Neuville much less than Mayer has not attempted a microscopical study of these vessels, that since he has not seen the connections of the superficial canals with the veins he does not know but that they may be only artifacts, and further declares that a histological investigation revealed the fact that these communications were found to be caused by the rupture of the venous wall, which is a contact wall between these two systems. Vialleton found (pp. 452–3) that there were distinct superficial and profundus lymphatic networks in the digestive tract of *Torpedo*, which could readily be told from the venous capillaries on account of the form of its network, its regular caliber, and greater volume. By injecting the lymphatics of the intestine

with blue and the veins with a nitrate of silver solution it was conclusively proved from a histological standpoint that these two systems were always distinct, often running side by side and entwining, but never anastomosing.

Like Neuville, Vialleton included only the viscera in his studies and devoted the first part of his work to a most excellent account of the history of the lymphatics of fishes. In reviewing Sappey's memoir (p. 392) he stated that the numerous anastomosing of the subcutaneous lymphatics with the veins, and the origin of certain lymphatic twigs from veins leads one to believe that the vessels described by Sappey as lymphatics are veins. It should be remembered, however, that Sappey used mercury for his injecting mass; hence it would not be surprising if these connections of the minute lymphatics with the veins, reported by Sappey (p. 24) in the abdominal region, are artifacts formed by the extravasations of the injecting mass.

Hopkins' most excellent paper on *Amia* (8) is to my knowledge the only work that has appeared on the Ganoids.

He finds that each lateral lymphatic trunk terminates anteriorly, in front of the pectoral arch, in a cephalic sinus, which extends from the clavicle into the base of the cranium, where it could be traced to a point opposite the orbit. About 1 cm. cephalad of the clavicle there is a valve, which closes an opening that leads ventrad into the jugular vein. Posteriorly each lateral trunk ends in a caudal sinus, which is located under the last vertebræ. Each sinus has a cephalic connection with the caudal vein, the orifice being guarded by a valve, and there are said to be at least two communications with its fellow sinus. The dorsal lymphatic trunk terminates anteriorly in the cephalic sinus, and posteriorly into one of the laterals after the latter bends to enter the caudal sinus. Hopkins is not positive whether this trunk bifurcates posteriorly with each fork terminating in one of the laterals or not, but thinks that it does. According to the writer the ventral trunk begins in the tail and communicates through a cross vessel with the lateral (Fig. 11, *t*). It collects the lymph from the anal and the ventrals, and in the neighborhood of the heart it forks, the two branches merging into the pericardial sinus, which discharges itself into

the cephalic sinus a little behind the jugular opening. A large pectoral sinus is said to lie at the base of the pectoral fin, which sends off branches to the lateral trunk and one to the pericardial sinus. The termination of the chylous system is in the ductus of Cuvier, on either side of the heart.

On p. 369 Hopkins states that: "In a specimen killed by pithing, the cephalic lymph sinus was exposed while the heart was still beating; the veins were gorged with blood but the lymph sinus appeared perfectly clear and transparent, and at no time was blood found in the lateral vessels. In several instances a clear fluid was seen to run out of the lateral vessel, when cut, in a fresh specimen."

Were not constant reference to this paper to occur in the text a far more complete report of it should be given here.

The latest work bearing on this subject is by Jossifoo (*op. cit.*). He takes up in detail the lymphatics in *Conger* and *Anguilla*. The main ducts of *Conger* (pp. 414–420) follow the vertebral column from the tail to the skull. In the caudal region the principal trunk (*L. Caud*, in Pl. 12) lies in the hæmal canal, directly below the caudal vein. When the thorax is reached it divides, forming the two *perivertebral lymphatic trunks* (*R.* and *L.Pr.S.*), which continue cephalad along the sides of the vertebral column. At the level of the fifteenth and sixteenth vertebræ the right trunk receives the lacteal canals (*D.Ch.*) from the viscera, and upon reaching the fourth vertebra a transverse vessel of considerable size (*La.*) connects the two trunks. At the base of the cranium each perivertebral trunk empties into a *cephalic sinus* (*S.C.*), which communicates with the jugular as it leaves the skull, and both the orifices of the vein and the lymphatic trunk are said to be guarded by semilunar valves. This sinus is so situated between the superior maxilla and the temporal bone that the act of respiration must necessarily dilate and contract it. In *Anguilla* the author (p. 418) states that upon injecting the perivertebral trunks one invariably fills the *branchial lymphatic sinuses*, situated outside the vertebral column between the gills. These sinuses communicate with the perivertebral trunks and serve as reservoirs to the lymphatic vessels arising from the mucosa of the branchial arches. A pulsating

lymphatic heart was found in the tail of *Anguilla*, but its connections with the lymphatic system were not made clear. A specimen of *Anguilla* was said to have lived several days in an aquarium after its tail had been cut off, without seeming to suffer from the operation.

From what we know of the development of the lymphatics in mammals[1] it would not be surprising to find in the embryos of the lower forms, if not in the adults also, even closer relationships between these two systems. For example, it might be possible to find a vessel that functioned both as a vein and a lymphatic trunk, and, again, an homologous vessel or system of vessels might exist, which functioned as veins in the more generalized forms, but which had their exact counterpart in lymphatic canals in the higher or more specialized forms. It is very evident from the above discussion that the last word has not been said on this subject. What is most needed is not more generalizations, but more anatomical and embryological data on many different groups, and especially in the Cyclosomes. It is not therefore my intention to make what might be considered a dogmatic statement as to whether these subcutaneous vessels in the Ganoids are veins or lymphatics. The chief aim will be to give an accurate description of the distribution of these vessels. They will, however, be described as lymphatics because the balance of evidence (such as size and arrangement of capillaries, and the fact that except in the branchial region the main ducts in the head region always accompany venous trunks), seems to warrant this view. Yet, on the contrary, it must be admitted that if these vessels are termed lymphatics in the branchial region no corresponding nutrient branchial veins were found; further,

[1] In an especially interesting paper Miss Sabin (27) found a stage in the embryo pig that about corresponded with the lymphatic system of the adult frog. Here there were two cervical hearts or sacs that received the lymph from the neck region and emptied into the cardinal vein at its junction with the subclavian, the opening being guarded by a valve. Similar posterior hearts were found to discharge themselves in the common vein formed by the union of the sciatic with the femoral, and their orifices were likewise said to be protected by valves. It was not until considerable later that the thoracic duct and the right lymphatic duct were formed from the anterior heart. To begin with, the lymphatic system of the pig is said to have its origin from two blind ducts that arise from the cardinal at its junction with the subclavian.

the branchial trunks were always filled with red corpuscles, and unquestionably terminated in and apparently formed the principal supply for the so-called inferior jugular vein.

II. DISTRIBUTION OF THE SUBCUTANEOUS VESSELS IN POLYODON.

The distribution of the subcutaneous vessels in the head region of *Polyodon*, which is a cartilaginous Ganoid, and *Lepisosteus*, a bony Ganoid, admits of so little comparison, that it seems advisable to consider this system of vessels separately in each case, rather than to take them up together in a comparative way. In the former these vessels, in some respects, agree more closely with the Selachians, while in the latter they are more like the Teleosts.

1. *Cephalic Sinuses and their Connections.*

What has been designated as the *cephalic sinuses* (Fig. 1, *Ceph.S.*) in *Polyodon* are two rectangular-shaped reservoirs, which are symmetrically placed on either side of the body, directly mesad of the supra-clavicles, and only a little below the level of the post-temporals. In the specimen from which Fig. 1 was drawn their dimensions were about 40 by 18 mm. With the exception of the posterior-ventral corner, each corner of a cephalic sinus has an orifice. The trunk leading into the posterior dorsal opening is the *lateral lymphatic trunk* (Fig. 1, *L.L.T.*). In the thoracic region the lateral trunks were the only subcutaneous vessels found; though both dorsal and ventral trunks were observed farther caudad. Very singular in *Polyodon* the lateral trunks have an extremely small diameter, but little, if any, greater than the lateral line canals. Fortunately, however, they increase in caliber upon approaching the cephalic sinuses; otherwise it would be impossible to inject them, except with a very fine hypodermic needle. What are represented as the *cephalic lymphatic trunks* (Fig. 1, *Ceph.L.T.*) terminate in the anterior dorsal corners of these sinuses, and in one way or another these great canals drain the entire head region. The openings from the anterior ventral corners lead into papillæ (Fig. 1, *V*), which discharge themselves ventrad into the jugulars; either at the angles of their great bends in front of the pectoral arches, or a little below.

So far as could be ascertained by dissections and injections no valves were found at the entrance of either the lateral or cephalic trunks in the cephalic sinus, or at the opening of the latter into the jugular vein, but as none of these orifices was large a histological study might have revealed their presence. Still, however, when the blood vessels were injected with a blue mass, the cephalic lymphatic trunks were invariably filled from either the lymphatic sinus or the inferior jugular connections or through both, and when the blue was allowed partially to solidify before the lateral trunk was injected with the yellow; it was found, upon dissection, that the yellow had forced back the blue a short distance in both the jugular and in the cephalic trunk, but none of it had reached the inferior jugular, showing conclusively that if there were valves at the entrance of the cephalic trunk opening into the cephalic sinus that after death, at least, they are unable to repel an injecting mass, when only a slight pressure is applied.

It will be readily noted that the cephalic sinus of *Polyodon* corresponds exactly in position to a similar reservoir described by Vogt (1, pp. 137–8) in the salmon, but its shape and mode of communications are very different. With the salmon this sinus is said to empty into the ductus of Cuvier, and in addition to receiving the lateral trunk it collects three mucous canals, as they are called, from the head region. The first of these canals is represented as arising at the origin of the temporal (pterotic) crest from two branches coming from the facial region. The second of these canals is portrayed (Pl. L, Fig. 1, 63) as having its source from six branches; one large and one small vessel coming from each of the first three branchial arches. The smaller branch is said to have its origin from the filaments; while the larger branch is a more superficial trunk, that continues ventrad along the surface of the arch to anastomose with the vein of Duvernoy (inferior jugular). The third canal comes from a common reservoir situated near the fourth vertebra, which is described as receiving a trunk from the fourth branchial arch, and one from the median part of the body that also collects the chylous duct.

Hopkins' cephalic sinus in *Amia* (8, p. 371 and Fig. 10, *b*)

is located a little further cephalad than the similar reservoir in *Polyodon*, being situated entirely in front of the pectoral arch. The writer observed that this sinus continued cephalad in the cranium to a point about opposite the orbit. As in *Polyodon* it is discharged into the jugular, but the orifice is said to be guarded by a valve opening into the vein. No cephalic trunks were represented as emptying into the cephalic sinus, but in addition to the lateral trunk a fork of the dorsal is said to have its termination in each.

Cephalic lymphatic trunk (Figs. 1, 2 and 3, *Ceph.L.T.*). — This is the largest and undoubtedly one of the most important of the lymphatic canals in *Polyodon*. In a 70-pound specimen it had a length of 12 cm., extending from the base of the skull to the pectoral arch, and connecting the so-called *hyo-opercularis sinus* (Figs. 1, 2 and 3, *Hyo.O.S.*) with the cephalic sinus. Its caliber if anything exceeded the jugular vein, but posteriorly it rapidly tapers down into a papilla preparatory to emptying into the cephalic sinus. In position it follows along directly above the jugular vein, about midway between the pterotic crest and the gills. The cephalic trunk is strictly a superficial canal, being separated from the branchial cavity by a thick skin that bears numerous leaf-like papilla; it is surrounded by a tough connective tissue, and cephalad a gland-like body, which I take to be the thymus, lies between it and the skin. The integment of this whole region contains a typical lymphatic network (Fig. 1, *L.N.*(1)), which is collected mesad by larger vessels that apparently discharge themselves into the dorsal end of the hyo-opercularis sinus rather than into this trunk. When the hyo-opercularis sinus is reached the cephalic trunk bifurcates: the dorsal fork communicates with the hyo-opercularis sinus from the rear and behind (Figs. 1 and 2, *C.L.T.O.*), while the ventral fork runs parallel, but mesad, of the hyo-opercularis sinus for a short distance. In this region the ventral fork receives at least two branches coming up along the inner surface of the branchial levator and the pharyngo clavicularis muscles. Corresponding venous trunks (Fig. 1) followed the course of these lymphatic branches and terminated in the jugular. Frequently as is shown in Fig. 1 a valve is

found in the hyo-opercularis fork of the cephalic trunk, at its junction with the ventral fork, which opens towards the cephalic sinus, but from its size one would not expect it capable of entirely closing the opening. A little posterior to the division of the cephalic canal a combined trunk formed from the fusion of the last three branchial lymphatic vessels (Fig. 1, *X*) is received from below, which will be described in detail later on under the head of the branchial lymphatic trunks.

What is termed the *pericardial lymphatic trunk* (Fig. 1, *Per.L.T.*) corresponds somewhat in position to the pericardial sinus of *Lepisosteus* and the Teleosts, without presenting anything like a sinus-like appearance. It is simply a canal running along in front of the pectoral arch in the connective tissue that surrounds the precava. Immediately after crossing the communicating vessel of the cephalic sinus with the jugular it makes a dorsal curve to culminate in the cephalic trunk, near its union with the cephalic sinus.

In several different specimens of *Polyodon* blood was removed with a pipette from the jugular and injected into a vial containing alcohol; likewise some fluid from the cephalic lymphatic trunk was placed in a second vial containing alcohol. Upon settling, the corpuscles from the vein had a distinct brown or reddish color; while those from the cephalic trunk were practically colorless. Microscopic sections of the two trunks reveal the walls to be structurally about the same. (Compare Fig. 22 with 23.) Both are composed mainly of fibrous connective tissue, with scattering smooth muscle fibers, and both have numerous papilla (*P*), which extend some little distance into the trunk and may to some extent function as valves. The greatest difference between these two vessels is in relation to their contents. The cephalic canal is filled with leucocytes and a few scattering red corpuscles, while in the jugular the red corpuscles greatly predominate; there being, however, in the latter a greater proportion of white corpuscles than would be found in the mesenteric or inferior jugular veins. With the cephalic trunk in the region covered by the field of Fig. 22 the red corpuscles were to the white as 8 is to 153; while with the jugular in the area covered by Fig. 23 the ratio of red to white was 36 to

19. Directly laterad of the cephalic canal, in this region, there is a gland-like body, the thymus, which is completely filled with leucocytes, and in places one can see them transuding through the walls of the lymphatic duct.

As regards its mode of origin, position, and point of termination the cephalic sinus of *Polyodon* corresponds somewhat with the second trunk described by Vogt in the salmon as emptying into the common reservoir (1, pp. 137–8 and Pl. L, Fig. 1, 63). Its position is also similar to Sappey's *sinus curviligne* in the skate (25, p. 20, and Pl. 5, Fig. 1, 5).

Hyo-opercularis sinus (Figs. 1, 2, and 3, *Hyo.O.S.*). — The sinus so designated is but little if any greater in diameter than the cephalic trunk; it is situated rather obliquely at the base of the skull, and is distinctly a superficial duct, which at one point crosses laterad of the jugular. Its length is apparently about the same in a 25-pound specimen as in a 70-pound one. Dorsad it receives a short vessel that collects the rich network (Fig. 1, *L.N.*(1)) from the skin and connective tissue in the region of the cephalic trunk. Its mode of connection or termination in the cephalic trunk has already been described. In one way or another it receives both forks of the *first branchial lymphatic trunk* (Figs. 1, 2, and 3, *Br.L.T.*(1′) and (1″)), which will be referred to in detail later on under the head of the branchial lymphatics. Laterad and ventrad it receives, or virtually is continuous with, the so-called *hyo-opercularis lymphatic trunk*, and, as shown in Fig. 1, a valve is often present at the junction of the two.

Tracing this important canal (Figs. 1, 2, 3, and 4, *Hyo.O.L.T.*) backward, it was found immediately before making a sharp curve caudad in order to pass along the outer surface of the retractor hyomandibularis muscle, a little above the hyomandibular, that it was joined by a significant *facial lymphatic trunk* (Figs. 1, 2, and 3, *F.L.T.*). Throughout its entire course the hyo-opercularis is distinctly a superficial canal, lying directly beneath the skin; it has its beginning from the hyoid arch and the opercle, and collects a network (Fig. 1, *L.N.*(3)) from the membranes and connective tissue of hyomandibular and its retractor muscle: this network communicates below

with what is designated as the *anterior facial lymphatic trunk* (Fig. 1, *F.L.T.*(1)). A cut through the spiracle region near the termination of hyo-opercularis trunk in the sinus shows that this canal is accompanied, more profundously, by a corresponding hyo-opercularis artery and vein. All of these vessels are enclosed in a fatty connective tissue, and even in uninjected specimens they are readily distinguishable. The lymphatic trunk is the most superficial and has by far the greatest caliber; no distinct walls were visible to the eye, and it appeared to be simply a regular cavity in the connective tissue, that increased in density in the neighborhood of the canal. A little mesad comes the vein, having visible walls, but with a caliber hardly half that of the lymphatic trunk. The artery, which is by far the smallest of the three, is some little deeper, and is characterized by very thick and well-defined walls. A short distance behind the anterior bend the hyo-opercularis trunk receives a large dorsal branch (Fig. 4, *Hyo.O.L.T.*(1)), which takes its origin from the outer dorsal surface of the retractor hyomandibularis muscle. At this point the hyo-opercularis artery and vein follow the hyomandibular rather than the lymphatic trunk, yet each sends off a superficial branch (Fig. 4, *Hyo.O.A.*(1) and *Hyo.O.V.*(1)) that crosses mesad of the lymphatic trunk, and which separates into two branches that follow the main hyo-opercularis lymphatic trunk and its dorsal branch. So that in this region, each lymphatic canal is accompanied by an artery and a vein.

Figures 24 to 26 represent microscopic sections of the hyo-opercularis lymphatic trunk, artery and vein. Except for the papilla, Fig. 24, *P.*, in the lymphatic trunk, there is but little difference between the structure of the lymphatic trunk and the vein, and both resemble the jugular and the cephalic lymphatic canal. When the hyo-opercularis lymphatic trunk was slit in a living specimen it was found to be practically empty, and sections show it to be almost destitute of corpuscles. Fig. 24 is taken from a very favorable section, and some of the few corpuscles portrayed here may have been shaken out from the meshes of the walls during the process of staining, but as the section stands it shows that the white corpuscles far exceed the

red, the ratio being 28 to 2. Fig. 26 represents the corpuscles as also being very scarce in the vein, but here the red predominate, the ratio being 9 to 2; while in the artery the corpuscles are abundant, the ratio of red to white being as 36 is to 8, which, however, is a striking number of white corpuscles for an artery. In the artery the three tunics are very thick and well differentiated.

Facial Lymphatic Trunks. — In *Polyodon* there are two such canals, on either side of the body, which for convenience sake have been designated as the *facial lymphatic trunks* and the *anterior facial lymphatic trunks*.

The latter trunks (Fig. 1, *F.L.T.*(1)) take their origin from the adipose tissue of the paddle, in front of the nasal sac. They are distinctly subdermal vessels, being situated some little distance above the orbito-nasal arteries and veins. When the level of the posterior border of the nasal sac is reached, each trunk bends outward and downward, to pass backward, superficially, along the surface of the adductor mandibulæ muscles. In the region of the spiracle it lies immediately in front of the facialis artery, and receives a rich network from above (Fig. 1, *L.N.*(2)), that passes over the facialis artery, nerve, and vein, to communicate above with the principal facialis trunk. Frequently vessels are received, which collect the network arising from the connective tissue that envelops the adductor mandibulæ muscles; these branches ordinarily accompany and often nearly encircle corresponding blood vessels. As previously stated in the neighborhood of the posterior extremity of the premaxilla, branches are received, that have their source from a rich network above (Fig. 1, *L.N.*(3)), which passes over the hyomandibular and its retractor muscle to communicate with similar branches that end in the hyoopercularis lymphatic trunk.

In connection with the anterior facial lymphatic trunk it was just noted that the main *facial lymphatic trunk* (Figs. 1, 2, and 3, *F.L.T.*) gathered a rich network in the region of the spiracle that came from the facialis vein, nerve, and artery, and was also in communication with the anterior facial trunk. The lymphatic canal thus formed follows up along the dorsal surface

of the facialis vein, and when the external carotid artery (Fig. 1, *E.Car.A.*) is reached, passes mesad with it in crossing under the external jugular vein (Fig. 1, *E.J.V.*), and then continues caudad a short distance, still mesad of the artery. From here on, instead of passing ventrad and mesad with the external carotid, it continues caudad on practically the same level, directly mesad of the external jugular and above the hyo-opercularis artery.[1] In this locality, which is about opposite the auditory capsule and a little above the spiracle, the facial trunk collects a very rich network from the surface of the external jugular and the hyo-opercularis artery. In company with the hyo-opercularis vein (Fig. 1, *Hyo.O.V.*) this trunk bends outward at right angles. In Fig. 1 it passes between the external jugular and the hyo-opercularis artery, following for a short distance below and in front of the hyo-opercularis vein, and then bends at right angles, crossing under the vein to terminate in the hyo-opercularis lymphatic trunk, at the point where it becomes the hyo-opercularis sinus. In Fig. 2 the facial lymphatic trunk after crossing under the external jugular, followed below the hyo-opercularis vein for a very short distance, before curving, to culminate in the hyo-opercularis trunk; while in Fig. 3, which is from the right side of the same specimen as Fig. 2, the facial trunk after coming out from under the external jugular, nearly encircles the hyo-opercularis vein, before emptying into the hyo-opercularis trunk.

2. *Branchial Lymphatics* (*Nutrient Branchial Veins?*).

These vessels present the most difficult proposition found in *Polyodon;* both in regard to tracing out their distribution, and in determining whether they are veins or lymphatics, or a common system that may function for both. In brief, each branchial arch possesses two main canals; one of which travels along the outer and inner surface of the arch; while the other is for the most part confined to the filaments, following along between the two rows or hemibranchs, with the efferent branchial artery,

[1] This artery (Fig. 1, *Hyo.O.A.*) is a large branch of the external carotid, that for a short distance runs caudad with the external jugular, before bearing off obliquely to the hyoidean region.

but distad of it. The latter is undoubtedly the principal trunk, for it often receives the former, and it is collected above by either the hyo-opercularis sinus or the cephalic trunk, and below by the inferior jugular. Considerable variation, however, is shown in both the dorsal and ventral endings, and as many deviations are to be found on the opposite sides of the same specimen as on the same sides of different specimens. Both the branchial trunks and the branchial arch trunks are connected by a very coarse network of capillaries, which are distinctly lymphatic in the character of their meshes. Transverse sections through the branchial trunk disclosed it to be full of red corpuscles, but at no point was a definite peripheral connection between a nutrient branchial artery established; although at several places hypothetical communications might occur.

The distribution of these branchial canals is practically the same for the first three arches; hence a description of the first arch of a 70-pound *Polyodon*, as shown by Fig. 17 will answer for all. As stated above the main *branchial lymphatic trunk* (*nutrient branchial vein?*) (*Br.L.T.*) travels in the connective tissue, midway between the two rows of filaments, parallel with, but distad of, the efferent branchial artery. For every pair of branchial filaments, a rather large *filament lymphatic trunk* (*nutrient vein?*) (Figs. 17, 18, 19, and 27, *Fil.L.T.*) is received from the connecting tissue lying between the two rows of filaments. A cross-section through these filaments (Fig. 27) reveals the fact that these branches do not lie opposite each pair of filaments as the two corresponding afferent filament arteries do (Figs. 17 and 27, *A.Fil.A.*), but rather about midway in the space separating one pair of filaments from the next, and Fig. 27 represents each of these filament vessels as being about equidistant from four afferent filament arteries. Numerous *transverse filament lymphatic vessels* (*nutrient veins?*) (Figs. 18 and 19, *Tr.F.L.V.*) entwine in various ways with the roots from which the corresponding afferent filament transverse arteries (Fig. 18, *A.F.Tr.A.*) take their origin, and form a very coarse plexus-like network between them. These vessels collect a very rich network from the outer surface of the filament (Fig. 19, *Fil.L.V.*), which in the region of the respiratory septa

have a somewhat rectangular arrangement. Certain twigs traverse the superficial layer of the filament, opposite to and parallel with the spaces separating the septa, and these are connected by transverse branches. This coarse network cannot be confused with the very fine respiratory network (Fig. 18, *Res.N.*); for the latter is more profundus, being confined to planes or septa, which are at right angles to the so-called lymphatic network. With a magnification of 450 diameters (Fig. 18*a*) the meshes of the respiratory network are not as large as the meshes of the lymphatic network as viewed with a magnification of 50 diameters (Fig. 19); hence the caliber of the respiratory capillaries is almost infinitesimal when compared to the lymphatics. After leaving the area of the respiratory septa, which is toward the outer edge of the filament, the lymphatic network assumes a somewhat different character; here, as is shown in the lower part of Fig. 19, the meshes become crowded closer together; while on the outer edge of the filament, in the region of the efferent filament artery, the meshes become elongated in the direction of the artery, which is exactly at right angles to their greatest length in crossing the filament. An examination of the basal portion of the filaments and the membranes overlying the efferent branchial artery with a lens (Fig. 17), or better still a microscopic preparation of this region (Fig. 20), discloses the fact that the lymphatic network of the branchial filaments are continuous with a similar network found on the outer and inner surfaces of the branchial arch (Figs. 17 and 20, *Br.A.L.N.*).

Branchial Arch Lymphatics (*Nutrient Veins?*). — One of these vessels (Fig. 17, *Br.A.L.T.*) runs along the inner surface of each arch, near its inner margin. It receives numerous radiating branches, which collect an extremely rich network (Fig. 17, *Br.A.L.N.*) that lies in the deeper membranes and connective tissue lining the arch, and which is distinctly lymphatic in the character of its meshes. This trunk also receives large accessory branches that gather a similar network from the other or outer side of the arch. So fine is this network that its meshes cannot be seen without the aid of a lens. At various intervals delicate branches could be traced to the outer membrane, where they collect an extremely minute capillary net-

work; so that each branchial arch would have a minute capillary network overlying and being connected with a more profundus and coarser network. Whether this outer capillary network was also in communication with the branchial arch arteries I am unable to state, any more than to say that no connections were found. A large number of small vessels were received from the gillrakers, the common arrangement being that two minute branches followed along the opposite surfaces of two neighboring gillrakers, collecting a minute network (Fig. 17, *G.R.L.N.*) found in the membrane joining the two, and uniting at the bases of the gillrakers to form a slender twig, which terminates in that porion of the branchial arch lymphatic network, overlying the efferent branchial artery (Fig. 17, *Br.A.L.N.*).

In the specimen from which Fig. 17 was drawn the arterial system was first filled with a blue mass, and afterward the subcutaneous system was injected with the yellow from the cephalic trunk. In certain areas, the minute capillary network found in the outer membrane covering a branchial arch was colored yellow and in other regions blue; similar colored areas were also found in the more profundus network, and in the superficial network of the branchial filaments. Other places also could be found in the more profundus network of the arch and the superficial network of the filaments, which were colored green, showing that the two injecting masses had fused. It does not, however, necessarily follow from the above, that these capillaries are in connection with arterial twigs. For in almost every case when the blood vessels were first injected, the cephalic trunk, the superficial network of the filaments, and the profundus network of the arch were found to be filled; doubtless through either the connection of the jugular with the cephalic sinus or the inferior jugular with the branchial lymphatic trunks, or through both. Since the profundus network of a branchial arch was found to be in communication with the minute superficial network, it is natural to expect that the mass found its way into this network after this manner, rather than through hypothetical arterial connections, which I have never been able to find, either from dissection or a microscopical examination; and upon inject-

ing the cephalic trunk with the yellow mass, it simply pushed back the blue, forming the conditions described above, viz., of certain areas of one color and other regions of a mixture.

Whether these conditions were obtained after this manner or were brought about through the media of peripheral communications with the nutrient arteries, might possibly be settled by removing a branchial arch from a large *Polyodon*, and after securely ligaturing both ends of the arch proper, plug up one end of the so-called branchial lymphatic trunk and inject from the other, but most unfortunately, however, these subcutaneous branchial vessels were not studied with any detail, until after I was removed some 2,000 miles from the source of material. Except for the fact that nutrient arteries were found on the arch, and no nutrient veins were observed, unless the so-called lymphatics function for both veins and lymphatics, I can see no reason for maintaintng that hypothetical peripheral connections exist between the nutrient arteries and the so-called branchial lymphatics. Certainly the methods resorted to in this study do not justify it; in fact, the numerous connections with the inferior jugular and the two with the jugulars rather forbid such a view.

A point slightly favoring the hypothesis that the branchial subcutaneous vessels function as veins, is the fact, that a section through a main branchial lymphatic trunk (Fig. 28) always shows a predominance of red corpuscles. The ratio of red to white is 37 to 22, which, however, lacks considerable of being so overwhelming as one would expect to find in a vein. For example in the inferior jugular, into which these vessels terminate ventrad, the ratio of red to white is about 12 to 1 and in the mesenteric vein one has to look some time to find a leucocyte; while in the cephalic trunk, into which these vessels culminate dorsad, the red corpuscles are very scarce, the ratio of white to red being 153 to 8. Hence from purely histological grounds one might infer that the branchial lymphatic trunks discharged themselves mainly into the inferior jugular, but the fact that none of the branchial arch trunks terminates in the inferior jugular, while some of them do empty directly into the cephalic trunk; and the additional observation that the branchial

lymphatic openings into the hyo-opercularis sinus and the cephalic trunk are larger than those into the inferior jugular, barely make this view even tenable.

Respiratory and Nutrient Branchial Arteries.—These vessels hold such an intimate relationship with the so-called branchial lymphatic system, and are so different from the similar arteries found in bony fishes, that a brief description of some kind seems to be called for.

With the exception of the last arch, which consists of a single hemibranch, the respiratory system is practically the same for the first three arches; so that the following description, which is taken from the first arch of a 70-pound *Polyodon* will answer for all. The main *afferent* and *efferent branchial arteries* (Fig. 17, *A.Br.A.* and *E.Br.A.*) maintain practically the same positions and connections as in other fishes. An *afferent filament artery* (Fig. 17, *A.Fil.A.*) is given off distad from the main afferent artery, to follow along the inner margin of each filament; its course lies in the connective tissue, close to the filament, and its distribution within the filament is a great deal more complex, than with other fishes that have been studied. At regular intervals (Fig. 18) rather large, but short, cross branches are given off, which are connected in an irregular manner; thus, forming a sort of secondary chain of arteries, from which the so-called *afferent transverse filament arteries* (Fig. 18. *A.F.Tr.A.*) take their origin. The latter vessels follow a nearly parallel course with one another, until near the filament septa, when each separates into from three to six branches, each of which furnishes the venous supply for a respiratory septum. In a 70-pound *Polyodon* the faces of these septa were about .1 mm. apart, which as shown by Figs. 18 and 18*a* must contain about the finest capillary network that exists. At the outer margin of each septum the respiratory network is collected by a rather short *efferent transverse filament artery* (Fig. 18, *E.F.Tr.A.*), which empties directly into the *efferent filament artery*, and all these vessels (Figs. 17 and 18, *E.Fil.A.*) pass proximad along the outer surface of the filaments, to discharge themselves in, and form, the great efferent branchial arteries (Fig. 17, *E.Br.A.*).

From both the lateral and mesal side of the efferent branchial artery, numerous branches, designated as *nutrient branchial arteries* (Figs. 17 and 20, *N.Br.A.*) arise to supply the membranes and connective tissue, overlying and underlying the efferent branchial artery. Two such branches were sent to the base of each filament. They were found on either side of the efferent filament artery, a little profundus of the lymphatic network, but could not be traced much beyond the base of the filament. Many branches were given off to the gillrakers, and forking to follow the dorsal and ventral surfaces of two adjacent rakers, they break up into a fine network in the membrane connecting them (Fig. 17, *G.R.N.*). Also very fine arterial twigs as *d*, Fig. 20, were frequently seen in the region bordering the filaments, but no connections, not even with the aid of a microscope, could be established with the so-called lymphatic network.

What is designated as the branchial arch artery[1] (Fig. 17, *Br.A.A.*) approaches the arch from the anterior dorsal corner. Shortly before the arch is reached it bifurcates. A large outer fork (*Br.A.A.*(1)) is given off to supply the outer surface of the arch, while the inner fork immediately makes a sharp curve to pass to the cephalic margin of the arch, and continues parallel with the lymphatic trunk. It is, however, a more profundus vessel, traveling for a good part of its length in a muscle overlying the inner surface of the arch. Branches are frequently given off to the muscle and the distal membranes, and they are often accompanied on either side and sometimes nearly surrounded by the so-called lymphatics. The caliber of the branchial arch artery and its branches is, however, only miniature, when compared with the corresponding lymphatic canals.

At this point there arises an apparent inconsistency. In all other parts of the head region in *Polyodon* we have arteries, veins, and lymphatics, running parallel with one another, but in the branchial arch and filaments (not taking the respiratory system into consideration) only arteries and lymphatics have been described. If peripheral connection had been established be-

[1] The source of this artery from the dorsal extremity of the efferent branchial artery has not been worked out as carefully as it should have been.

between these so-called lymphatics and the nutrient arteries, one might claim that these branchial lymphatics are nutrient veins, which receive a network decidedly lymphatic in character, that is continuous from the great trunk passing through the gills to the main trunk of the branchial arch, and which may function both for a venous and a lymphatic system, terminating above in a lymphatic trunk and below in a vein.

Possibly it should be noted here that the fourth or last branchial arch has but one row of filaments, and is therefore a hemibranch. Except for some variation in connection with the efferent branchial artery, which will doubtless be fully noted in a forthcoming paper, by Mr. E. P. Allis on the blood vessels of *Polyodon*, the lymphatics and the blood-vascular systems of the fourth arch correspond very closely to a hemibranch of one of the other arches.

Dorsal and Ventral Endings of the Branchial Lymphatic Trunks (*Nutrient Branchial Veins?*). — Great variation is shown not only in the dorsal and ventral terminations of these trunks in different specimens, but also on the opposite sides of the same specimen. In tracing out the culmination of these vessels I found it frequently useful to insert a canula into one of these trunks and force water with the aid of a syringe into the trunk; and having previously removed a portion of the sinus or trunk into which it is discharged, note the orifice through which the water was ejected.

Fig. 1 shows the dorsal endings of the branchial lymphatic trunks, as seen from the left side of a 70-pound *Polyodon*, and Figs. 2 and 3 represent the dorsal mode of termination of these trunks on the opposite sides of a 25-pound *Polyodon*. In every case the *first branchial lymphatic trunk* (*Br.L.T.*(1)) bifurcates when about to leave the arch. In Fig. 1 the ventral fork (*Br.L.T.*(1′)) continues cephalad in about the same plane until the hyo-opercularis sinus is reached, when it bends dorsad to follow along the mesal surface of the hyo-opercularis sinus for a short distance, and immediately after receiving the dorsal fork (*Br.L.T.*(1″)), the combined trunk opens into the hyo-opercularis sinus through the inner wall (*Br.L.T.*(1)*O.*). With the specimen from which Figs. 2 and 3 were drawn, both of

these forks opened separately into the hyo-opercularis sinus; the only difference on the two sides being that on the right side (Fig. 3) the openings were further apart. In every case the ventral fork followed along the anterior margin of the first branchial levator muscle, and the dorsal fork traveled along behind the same muscle.

The final dorsal termination of the second, third and fourth branchial lymphatic trunks are so different in these three dissections that a brief description should accompany each, although a far better idea can be obtained by carefully comparing Figs. 1, 2 and 3. In Fig. 1 the third branchial lymphatic trunk unites with the fourth, behind the posterior border of the third and fourth branchial levator muscles, and the common trunk (*Br.L.T.*(3) and (4)) continues dorsad behind the muscle until the jugular is reached, when it receives from in front the second branchial lymphatic trunk (dorsal fork of the second branchial lymphatic trunk?), and the combined trunk (*x*) after crossing over the jugular empties into the cephalic trunk, a short distance behind the hyo-opercularis sinus. In Fig. 2 the fourth branchial lymphatic trunk unites with a rather large branch that comes up from the pharyngo-clavicularis muscle, and very shortly is joined from the rear by the third branchial lymphatic trunk. The course of this common trunk (*Br.L.T.*(3) and (4)) is then obliquely dorsad, following along the inner surface of the second branchial levator muscle; it soon collects the dorsal fork of the second branchial lymphatic trunk, and the combined trunk thus formed (*x*), discharges itself mesad of the hyo-opercularis sinus in the ventral fork of the cephalic trunk. The remaining ventral fork of the second branchial lymphatic trunk (*Br.L.T.*(2)) travels mesad of the first and second branchial levator muscles, and likewise terminates in the ventral fork of the cephalic trunk, a little below trunk (*x*). In Fig. 3 the third branchial lymphatic trunk makes a sharp curve on the outer surface of the arch, where it receives a common trunk, formed from the union of the fourth branchial trunk with a vessel coming from the occipito-clavicularis muscle and the region behind the fourth branchial arch. The dorsal fork of the second branchial lymphatic trunk after traveling along the posterior

edge of the second branchial levator muscle, makes a curve at right angles to pass obliquely ventrad along the inner surface of the second branchial levator muscle, where it shortly bifurcates at right angles, one fork continuing obliquely ventrad terminates in the dorsal arm of the great bend of the combined trunk from the third and fourth arches, while the other fork passes dorso-cephalad for a short distance and receives a large communicating branch from the combined trunk of the third and fourth arches, thus forming trunk (*x*), which, after bending at right angles, passes dorso-caudad to discharge itself in the cephalic trunk, a little behind the hyo-opercularis sinus. As on the opposite side, the ventral fork of the second branchial lymphatic trunk empties into the ventral fork of the cephalic trunk.

Only a few of the so-called lymphatics from the branchial arches have been traced out, and they either terminated in the main branchial trunks or in the ventral fork of the cephalic trunk. In Fig. 3 the trunk from the first arch culminated in the ventral fork of the first branchial trunk, at a point indicated by *Br.A.L.T.*(1), and the one from the third arch (*Br.A.L.T.*(3)) ended in the ventral fork of the cephalic trunk, directly above the opening of the ventral fork of the second branchial trunk.

Ventrad, the termination of the first two branchial lymphatic trunks in the inferior jugular are practically the same for all the specimens, but considerable variation exists in regard to the endings of the third and fourth trunks, both in different specimens and on the opposite sides of the same specimen.

As shown in Fig. 5 the first and second branchial lymphatic trunks (*Br.L.T.*(1) and (2)), in their ventral course, finally get to lie immediately behind their corresponding afferent branchial arteries. When close to the ventral aorta, the second trunk crosses over the ventral surface of the second afferent artery, then passing cephalad, in close proximity to the ventral aorta, it crosses below the second obliquus ventralis muscle to anastomose with the first trunk. Both the first and second branchial trunks communicate above with the inferior jugular. The former connection (Figs. 5, 6 and 7, *Br.L.T.*(1) *V.O.*) leads up between the sterno-hyoideus tendon and the ventral

aorta, and the first afferent branchial artery and the second obliquus ventralis muscle; so far as could be ascertained it was the first vessel to join the inferior jugular. The latter connection (Figs. 5, 6 and 7, *Br.L.T.*(2)*V.O.*) passes up between the second obliquus ventralis muscle, ventral aorta, and second afferent branchial artery. In the specimen from which Figs. 5 and 6 were drawn there was a large dorsal opening in the inferior jugular (Fig. 6, *M.O.*), which in front lead into a sinus designated as (*M*) that received two sacs from the rear (*V*). Into the left sac the corresponding fourth branchial lymphatic trunk empties, and the right sac receives a short trunk (Figs. 5 and 6, *S.T.*) that encircles the inferior jugular, and communicates below with a *ventral sinus* (*S*). En route it collects the fourth right branchial trunk (Fig. 5, *Br.L.T.*(4)) from the rear; while the remaining third left branchial trunk (Figs. 5 and 6, *Br.L.T.*(3)) empties directly into the inferior jugular, a little in advance of sinus (*S*).

In the specimen from which Fig. 7 was drawn the third and fourth branchial lymphatic trunks had an entirely different mode of ending from that described above. No dorsal sinus emptied into the inferior jugular, but a *ventral sinus* (Fig. 7, *S*) was present and occupied a similar position as in Fig. 5. Its communicating trunk (*S.T.*) connected directly above with the inferior jugular instead of encircling the right side of the inferior jugular as in Fig. 5. The ventral sinus in Fig. 7, *S*, received the third right branchial trunk in front, and in addition the fourth left branchial trunk from the rear; while the fourth right and the third left branchial trunks terminated directly in the inferior jugular.

The course of the inferior jugular in the branchial region is too irregular and complex to permit of a description. Fig. 6 gives a general idea of its form and its anterior communications. Here it is simply a very thin irregular sinus, conforming to the general arrangement of the branchial arches and the ventral aorta and its branches. In the neighborhood of the union of the third and fourth pair of afferent branchial arteries (Fig. 6, *A.Br.A.*(3) and (4)) it not only surrounds them, but passes dorsad between them.

Like *Acipenser* and *Scaphirhynchus* the ventricle of the heart of *Polyodon* is conspicuous for the amount of lymphoid tissue surrounding it. There is always one large lymphatic gland encircling the anterior part of the ventricle; another smaller one is situated behind it on the lower side of the ventricle, inclosing the greater portion of the posterior end of the ventricle. It is very singular in *Polyodon* that the *coronary artery*, which supplies these glands as well as the heart, comes from the fourth right efferent branchial artery and approaches the heart from the rear. When the ventral side of the sinus venosus is reached it trifurcates. Two of these branches pass cephalad between the auricle and the ventricle, supplying each; while the third follows along the left and ventral border of the ventricle, and gives off branches that traverse between the surface of the ventricle and these glands, supplying each. Corresponding venous branches arise from the anterior and left ventral side of the ventricle, which likewise pass between these glands and the ventricle to terminate in two *longitudinal coronary veins* that travel caudad between the auricle and ventricle. At the posterior apex of the heart these two veins anastomose, forming the *common coronary vein*, which discharges itself into the sinus venosus from below. For the most part the blood-vascular network lies between these glands and the ventricle. In addition to the vascular network described above there is a coarser and more superficial network, decidedly lymphatic in the character of its meshes, which encompasses these glands. This is undoubtedly a lymphatic network, but so far as could be determined it was not collected by any definite lymphatic canal. Consequently it must, as Robin found in *Torpedo* (*op. cit.*, pp. 15 and 16), reach the veins through the œsophagus plexus. One finds upon sectioning this lymphoid tissue surrounding the heart that it somewhat resembles the thymus. It consists of a connective tissue framework which is completely filled with leucocytes. In addition to the numerous blood vessels that traverse it, many lymphatic spaces or sinuses were found which were filled with leucocytes.

III. DISTRIBUTION OF THE SUBCUTANEOUS VESSELS IN LEPISOSTEUS.

In this genus the subcutaneous vessels of the head, especially the region adjoining the branchial arches and the heart, are far more sinus-like than in *Polyodon* or the Selachians, and in this respect they resemble the Teleosts. The so-called cephalic sinus in *Lepisosteus* occupies a position entirely in front of the branchial arches, which is far cephalad of its position in *Polyodon* or as set forth by Hopkins for *Amia* (*op. cit.*, pp. 371–2), and corresponds about to its position in *Scorpænichthys* and other bony fishes. Other interesting points such as a communication of a so-called dorsal pericardial sinus with the inferior jugular and separate dorsal and ventral branchial trunks will be described at length later on in the text. Of the three species of *Lepisosteus* that were studied no more variation could be found than in different individuals of the same species.

Longitudinal Lymphatic Trunks. — With *Lepisosteus* as in *Amia* and the bony fishes there are four such canals in the thoracic as well as in the abdominal and caudal regions. They are respectively dorsal, ventral, and lateral in position. A transverse section as Fig. 16 shows that they are enveloped in a mass of connective tissue, which is imbedded more or less within the myotomes. To the unaided eye they appear like cavities in this connective tissue. The outer walls of these vessels lie directly below the skin and are frequently ruptured upon removing the horny exoskeleton. Except for their enormous caliber and their different cephalic termination they do not differ materially from the similar canals of *Scorpænichthys*. The great *lateral lymphatic trunks* (Figs. 8, 9, 11, 12 and 16, *L.L.T.*) upon approaching the thoracic region gradually leave the median lateral line to assume a more and more dorsal position. Accompanying the ramus lateralis vagi each trunk passes beneath its corresponding pectoral arch to culminate in what has been designated as the occipital sinus (Figs. 8, 9, 11 and 12, *Oc.S.*) instead of emptying into the cephalic sinus as in *Polyodon* or *Amia*. The *dorsal lymphatic canal* (Figs. 8, 11, 12 and 16, *D.L.T.*) travels along the median dorsal surface of the trunk, and likewise has a very different ending from what Hopkins

found for *Amia* or from *Scorpænichthys*. Instead of bifurcating behind the skull and each fork terminating in the cephalic sinus as one might expect, this canal when not far from the posterior end of the skull passes ventrad along the left side of the connective tissue separating the two great lateral muscles, and when the vertebral column is reached it bears off obliquely laterad to cross below the exoccipital portion of the skull and terminates in the anterior part of the left branchial sinus (Figs. 8, 11 and 12, *Br.S.*) from the inner side. In every specimen of *L. tristœchus* and in several of *L. osseus* the *ventral lymphatic trunk* (Figs. 8 and 13, *V.L.T.*) forked at the level of the base of the pectoral fins, and each of these branches, which immediately become sinus-like, continues parallel until the level of the bulbus arteriosus is reached, when they bear off at right angles to pass between the clavicle and pericardium and culminate in the corresponding pericardial sinuses (Figs. 8 and 13, *Per.S.*). In that part of their course which lies between the pectorals and the heart they are separated only by a sheath of tough connective tissue, in which there are at least two connecting orifices. With an equal number of *L. osseus*, as shown in Figs. 14, 15 and 16, the ventral trunk did not fork in the region of the pectorals, but continued cephalad as a single trunk, and when the heart was reached it joined the right pericardial sinus.

As represented in Figs. 14, 15 and 16 the ventral lymphatic trunk is accompanied by a *ventral vein* (*V.V.*), which passes to the left of the heart to discharge itself (Fig. 15) in the left precava a little laterad of the orifice of the hepatic vein. Two *ventral arteries* (Figs. 14 and 16, *V.A.*) also accompanied the lymphatic trunk for a short distance.

Numerous *intermuscular lymphatic vessels* (Figs. 8 and 11, *Intm.L.V.*) were given off from either side of the dorsal trunk, or from above and below in case of the lateral trunk. These vessels traversed superficially on the septa between the myotomes. They doubtless connected the lateral with the dorsal and ventral trunks as in *Scorphœnichthys* and other fishes, but this fact was not established for a certainty in *Lepisosteus*.

Pericardial Sinuses. — Each of these sinuses in *Lepisosteus* (Figs. 8–14, *Per.S.*) occupies a like position to a similar sinus

in *Scorpænichthys* and *Amia*. In *Lepisosteus* it follows along the front and inner surface of the pectoral arch parallel with the precava. Dorsad at about the level of the last branchial arch it communicates with what is designated as the *occipital sinus* (Figs. 8–12, *Oc.S.*), which continues ventrad, mesad of the pericardial sinus, and shortly after receiving the *pectoral sinus* (Figs. 8 and 9, *P.S.*), it again joins the pericardial sinus from the inside through a very large orifice (Figs. 8–10, *Oc.S.O.*). As already stated, in the region of the heart one or both of the pericardial sinuses receive the ventral lymphatic trunk or a fork of it. After which the pericardial sinus proceeds along the lateral surface of the ventricle, just outside the parietal layer of the pericardium, and when the bulbus arteriosus is reached each of the pericardial sinuses has a very large opening (Figs. 8, 9, 13, 14 and 15, *Per.S.O.*), which leads into a large canal that passes mesad and empties into the posterior end of the so-called *dorsal pericardial sinus*. This sinus (Figs. 13 and 15, *D.Per.S.*), which is located directly above the bulbus arteriosus, has the form of an ellipse with its longest axis corresponding with that of the fish. In a 10-pound *L. osseus* its dimensions were 15 by 8 mm. There is always a communication above with the inferior jugular vein. In the specimen from which Fig. 15 was drawn there were two such openings, both of which were located in the posterior half of the sinus, and were guarded by a pair of semi-lunar valves (*D.Per.S.V.*) opening into the vein. In this specimen there was a third aperture in the anterior dorsal wall of this sinus, but it led only into a small blind pocket. This mechanism in *Lepisosteus* recalls a sort of hypothetical connection of the ventral pericardial sinus with a branch of the inferior jugular in *Scorpænichthys* (*op. cit.*, p. 75). At the points where the connecting branches are given off from the pericardial sinuses to the dorsal pericardial sinus two *anterior pericardial canals* are received (Figs. 13, 14 and 15, *Per.S.*(1)). These doubtless are nothing more than the anterior continuations of the pericardial sinuses, which extend for a short distance along the ventral surface of the parietal layer of the pericardium.

Occipital Sinus (Figs. 8–12, *Oc.S.*). — As will be readily

noted, the sinus so designated occupies a somewhat similar position to the cephalic sinus of *Amia*, *Polyodon*, and *Salmo*. It likewise receives the lateral lymphatic trunk and is connected below with the pericardial sinus, but does not communicate directly with the jugular or the precava; hence the term cephalic sinus has been reserved for a sinus located further cephalad, that corresponds in position to a similar sinus in *Scorpænichthys*, and which terminates directly in the jugular vein. The occipital sinus is therefore a spacious reservoir, situated directly above the epibranchial of the last branchial arch, in front and a little median of the pectoral arch, and immediately behind the last branchial levator muscle. It also lies above and behind what is represented as the *branchial lymphatic sinus* (Figs. 8, 9, 11 and 12, *Br.S.*), from which it is separated by a very thin membrane. A little dorsad and mesad of the fourth epibranchial bone there is an orifice (Figs. 8, 9, 11 and 12, *Br.S.O.*) in the ventral wall of the occipital sinus, which communicates below with the branchial sinus. Laterad and a little below the level of the epibranchial of the fourth arch it is in connection with, or possibly might better be represented as receiving, the pericardial sinus. At this point the occipital sinus passes ventrad along the inner surface of the pericardial sinus for some distance, to again communicate more ventrad with the pericardial sinus (Figs. 8 and 10, *Oc.S.O.*). No special effort has been made to work out in detail the distribution of the lymphatics in the pectoral fin, but nevertheless in all three species of *Lepisosteus* a large *pectoral sinus* (Figs. 8 and 9, *P.S.*) was found at the base of each pectoral fin. With *L. osseus* it collected numerous branches that traveled along the dorsal surfaces of the rays and gathered a network from the adjacent membranes. Only one branch per ray, however, was found in *L. osseus:* whereas in *Scorpænichthys* each ray possessed two vessels, which collected a network from the adjoining membrane connecting two rays. Upon reaching the anterior proximal part of the fin the pectoral sinus makes a bend at right angles, and after crossing diagonally over the outer surfaces of the superficial and profundus pectoral adductor muscles it again makes a curve at right angles to pass cephalad between the profundus pectoral

adductor muscle and the great lateral trunk muscle, to discharge itself in the occipital sinus.

Branchial Lymphatic Sinuses (Fig. 8, 11 and 12, *Br.S.*). — Each of these reservoirs is a cavity of considerable size, which occupies most of the space above the superior pharyngeal region between the auditory capsule and the levator branchial muscles, and is separated from the skull only by the jugular vein. Its posterior depth is double the anterior. This difference in depth is not due to a gradual tapering down of the sinus, but rather to an abrupt rise in the level of the floor a little forward of the center of the sinus; so that this sinus might almost be said to consist of an anterior and a posterior portion. The anterior division lies directly mesad of the first and second branchial levator muscles (Figs. 11 and 12, *L.Br.A.*(1) and (2)). Cephalad it tapers down into a sort of papilla, which curves around these two branchial muscles to unite in front with a papilla from the hyo-opercularis sinus in forming the so-called *cephalic sinus* (Figs. 8, 11 and 12, *Ceph.S.*), which empties into the jugular. Directly mesad of the first branchial levator muscle there is an orifice in the floor of the anterior portion of the branchial sinus (Figs. 11 and 12, *D.Br.L.T.*(1)*O.*) through which a trunk formed from the union of the first dorsal branchial lymphatic trunk (Figs. 8 and 9, *D.Br.L.T.*(1)) and a fork of the second dorsal branchial lymphatic trunk is discharged. What might be designated as the posterior mesal corner of the left anterior branchial sinus receives the dorsal lymphatic trunk (Figs. 8, 11 and 12, *D.L.T.*). Leaving now the anterior part of the branchial sinus we find that the posterior portion of this sinus extends caudad and ventrad beneath the occipital sinus, and in the neighborhood of the epibranchial of the last branchial arch it communicates above with the occipital sinus (Figs. 8, 9, 11 and 12, *Br.S.O.*). In *L. osseus* there is an opening in the anterior ventro-lateral corner of the posterior part of the branchial sinus (Fig. 12, *D.Br.L.T.*(2)*O.*) through which one fork of the second dorsal branchial lymphatic trunk is discharged. This orifice is situated almost opposite the space between the second and third branchial levator muscles. There is still another aperture about opposite the fourth branchial levator muscle

(Fig. 12, *D.Br.L.T.*(3)*O.*) into which the third dorsal branchial lymphatic trunk opens.

In position the branchial lymphatic sinus corresponds somewhat to the so-called hyo-opercularis sinus and the anterior part of the cephalic trunk of *Polyodon*. Its inclination to become separated into two divisions recalls the two branchial sinuses of *Scorpænichthys* (*op. cit.*, Pls. II and III; Figs. 4 and 5, *Br.L.S.*), which were situated above the epibranchials of the first and second, and the third and fourth arches, respectively, but were some distance laterad of their position in *Lepisosteus*, being located outside the branchial levator muscles, and the space between the branchial levator muscles and the skull in *Scorpænichthys* was occupied by the anterior continuation of the abdominal sinus and the cranial lymphatic trunk together with the jugular vein. In *Ophiodon* and *Scorpænichthys* no branchial lymphatic trunks were observed, but in the former nutrient veins were found emptying directly into the jugular.

What is designated as the *hyo-opercularis sinus* in *Lepisosteus* (Fig. 11, *Hyo.O.S.*) is completely drawn on the right side only. It is a reservoir of considerable size situated on the inner side of the operculum, above the gills. So closely does it adhere to the operculum that it is impossible to remove this bone without rupturing its walls. This sinus is very much depressed and conforms to the general curvature of the body. As in *Scorpænichthys* it may be said to end dorso-cephalad in a papilla, which in *L. tristœchus* expands into a distinct sinus immediately laterad and cephalad of the first branchial levator muscle, to which the name *cephalic sinus* has been given.

This sinus (Figs. 8, 11 and 12, *Ceph. S.*) is joined from the inside by the branchial sinus, and directly in front of this point of union the cephalic sinus bends at right angles to pass mesad and discharge itself in the jugular at a point about opposite the cerebellum. With *L. tristœchus* the cephalic sinus has much more the appearance of a reservoir than in *L. osseus* (compare Fig. 11 with 12). In the latter it is nothing more than a canal; while even in *L. tristœchus* it falls far short of its size in *Scorpænichthys*, and is somewhat smaller than the corresponding sinus of *Polyodon*.

The positions of the cephalic sinuses and their points of termination in the jugulars are about the same as in *Scorpænichthys*, but their connections and positions in *Amia*, *Polyodon* and *Salmo* are very different. Hence these somewhat dissimilar sinuses may be only analogous. I take the term *cephalic sinus* to be nothing more than an arbitrary name given to a dorso-cephalic sinus that is in connection with all the subcutaneous vessels and which terminates directly in the jugular vein, or possibly the precava in some species.

Branchial Lymphatic Trunks (*Nutrient Veins?*).[1] — These vessels in *Lepisosteus* have not been worked out with anything like the detail that they were in *Polyodon*. Each arch possessed a *dorsal* and a *ventral* trunk that traversed between the two rows of filaments, parallel with, but distad of, the afferent branchial artery, and which so far as could be ascertained had no connection with one another. No effort was made to trace out the origin of these vessels from the filaments, and nothing more was attempted than to follow these canals to their ultimate termination. In *Lepisosteus* the branchial arches are round and only miniature when compared with *Polyodon*. They are surrounded by a spare amount of spongy connective tissue, containing only a few corpuscles in its meshes and a small number of blood vessels.

The *first dorsal branchial trunk* (Figs. 8 and 9, *D.Br.-T.*(1)) takes its origin a little above the center of the arch from between the two rows of filaments. Upon leaving the most dorsal pair of filaments it travels along the anterior margin of the first branchial levator muscle, receives a fork (Fig. 8) from the second branchial trunk; then curving to the mesal side of the muscle, penetrates the floor of the anterior part of the branchial sinus, through an opening (Figs. 11 and 12, *Br.L.T.*(1)*O.*) about opposite the first branchial levator muscle. The *second dorsal branchial trunk* (Figs. 8 and 9, *Br.L.T.*(2)) arises in like manner from the dorsal filaments of the second arch, and after leaving the arch it forks between the

[1] As in the case of the branchial trunks of *Polyodon* the method of forcing water through these trunks and noting the points of its exit was resorted to with advantage in *Lepisosteus*.

second and third branchial levator muscles; the anterior branch continuing on across the outer surface of the second branchial levator muscle, unites with the first branch mesad of the first levator muscles; while the posterior branch passes mesad between the second and third branchial levator muscles to terminate in the anterior ventral corner of the posterior part of the branchial sinus through an orifice designated in Figs. 11 and 12 as *D.Br.L.T.*(2)*O.* The *third branchial trunk* after leaving its arch curves around the fourth levator muscle to culminate in the floor of the posterior division of the branchial sinus about opposite the fourth branchial levator muscle (Figs. 11 and 12, *D.Br.L.T.*(3)*O.*); whereas the trunk from the fourth arch discharges itself in an entirely different sinus. Its opening (Figs. 8, 9, 11 and 12, *Br.L.T.*(4)*O.*) is through the inner wall of that part of the occipital sinus which lies mesad of the pericardial sinus.

All of the so-called *ventral branchial trunks* doubtless terminate in one way or another in the inferior jugular vein. This is certainly true for the first three pairs, but the final ending of the last pair I have never been able satisfactorily to trace out. Each of these ventral branchial trunks has its source from the ventral filaments, and traverses between the two hemibranchs, in company with, but distad of, the afferent branchial artery. The first pair of these vessels discharged themselves through two orifices (Figs. 14 and 15, *V.Br.L.T.*(1)*O.*) situated in the dorsal walls of the right and left forks of the inferior jugular, directly in front of their corresponding afferent branchial arteries. In the specimen from which Figs. 14 and 15 were drawn, the second right branchial trunk joined the right fork of the inferior jugular exactly in front of the second right afferent branchial artery through an orifice designated as *V.Br.L.T.*(2)*O.* The precise point of union of the third right trunk was not located, but upon injecting this vessel ventrad with water it was discharged through the opening of the right fork of the inferior jugular into the inferior jugular (Fig. 15, *R.I.J. V.O.*), indicating of course that it came from the inferior jugular. In the dorsal wall of the left fork of the inferior jugular, immediately behind the second left afferent branchial artery, there is

an orifice (Fig. 15, *E.*), which leads cephalad into a pocket through which water is ejected upon injecting either the second or the third left branchial trunks. Neither from dissection nor from the water injection method could the termination of the fourth pair of branchial trunks be located. Undoubtedly, however, they are discharged into the inferior jugular vein.

As shown in Fig. 15 the *inferior jugular vein* in *Lepisosteus* arises in the branchial region from two branches, which unite immediately behind and above the combined trunk formed by the union of the last pair of afferent branchial arteries; the right fork, however, extends caudad for a short distance as a blind sac. Thus formed, the main stem of the inferior jugular (*I.J. V.*), passes caudad above and parallel with the ventral aorta. Dorsad of the bulbus, as already noted, it receives one or more communications from below from the so-called dorsal pericardial sinus; after which it bears off obliquely to the left to discharge itself in the left sinus venosus. It seems in *Lepisosteus* that this sinus is divided, and the opening into the auricle below is from the left side (Fig. 15, *S. Ven. O*). Both sinuses receive a precava or ductus of Cuvier, but the hepatic and ventral veins, so far as could be ascertained, terminated in the left precava.

IV. DEDUCTIONS AND SUMMARY.

From the preceding discussion it would seem that the subcutaneous vessels of the Ganoids occupy a position fairly well between the generalized Selachians and the more specialized Teleosts or Batrachians. There is a vast difference between the character and distribution of these vessels in the *Chondroganoidea* (the cartilaginous ganoids) and in the *Holostei* (the bony ganoids). *Polyodon* as a representative of the former group has non-sinus subcutaneous vessels, which in structure are not very dissimilar to the corresponding veins, and in this respect resemble the subcutaneous vessels of the Selachians, which have been described by many authors as veins. While in *Lepisosteus*, which is one of the bony Ganoids, many of the subcutaneous vessels are thin-walled and decidedly sinus-like; in this respect resembling the conditions as found in the Teleosts and Batrachians.

With the Ganoids, especially in the branchial region, it is a very difficult proposition to determine whether these subcutaneous vessels are lymphatics or veins or a common system that may function for both. For the present, until after the embryology has been studied, and this system has been worked out in the Cyclostomes, it has seemed best to leave it as an open question. These vessels have, however, in this paper been described as lymphatics for the following reasons: In every part of the head, excepting the branchial region, each of the main subcutaneous canals is accompanied by a corresponding artery and vein, and frequently the arterial and venous branches are surrounded on either side by branches of these subcutaneous vessels. They receive a superficial network, which is distinctly lymphatic in the character of its meshes, and which is often continuous with another subcutaneous canal of the same class, and never to my knowledge with a corresponding arterial trunk. Excepting the branchial trunks, as far as could be ascertained, all of the subcutaneous canals contain a predominance of white corpuscles; although in some of the trunks they may be very scarce. If the longitudinal subcutaneous canals of the trunk were considered as veins it would be necessary to treat them as a separate venous system, that had no counterpart in the arterial system. As in the Teleosts the principal arterial trunks of this region are the aorta and the caudal artery which are accompanied by the cardinal and caudal veins. From these vessels are given off or received the neural, hæmal, and the lateral branches, which extend to the skin and fins to supply or collect the blood from the region drained by the superficial longitudinal trunks.

So far as could be determined in the branchial region of the Ganoids there is a nutrient branchial arterial system, but no nutrient venous system was observed unless the so-called branchial lymphatic system functions for both veins and lymphatics. In *Lepisosteus* each arch had a dorsal and ventral branchial trunk, the latter terminating below in the inferior jugular and the former in a branchial sinus, which was in connection with the cephalic and pericardial sinuses. With *Polyodon* but one branchial lymphatic trunk travels between the branchial fila-

ments of an arch. Throughout its course it collects a rather coarse network of capillaries from the filaments, which is in direct communication with what is designated as the branchial arch lymphatic trunk, and further this network on the arch is in connection with a very fine and more superficial network, which so far as could be learned had no connections with the corresponding arteries. These branchial arch trunks terminate dorsad either in the common branchial trunk or in the ventral fork of the cephalic canal, while the main branchial trunks in *Polyodon* discharge themselves ventrad in the inferior jugular and dorsad in the cephalic canal and the hyo-opercularis sinus.

A comparative study of the cephalic sinuses in this group apparently does not throw much light on the phylogeny of the lymphatic system. *Polyodon*, the most primitive member of this series, has a cephalic sinus, which in position and connections resembles a similar reservoir in *Amia* and *Salmo*, while the cephalic sinus of *Lepisosteus* is more closely allied to a like sinus in *Scorpænichthys* and other Teleosts. This reservoir in *Polyodon* is situated just mesad of the supraclavicle. It receives the great cephalic canal from in front which drains the entire head region, the lateral lymphatic trunk from the rear, and emits itself ventrad into the jugular vein. With *Lepisosteus*, especially *L. osseus*, this reservoir is hardly deserving the term sinus. It is far cephalad of its position in *Polyodon*, and as in *Scorpænichthys*, lies about opposite the auditory capsule. From the rear it receives the hyo-opercularis and branchial sinuses. The latter is in connection with a series of sinuses that surround the branchial cavity and gather the subcutaneous vessels from the remainder of the body, and about opposite the cerebellum the cephalic sinus discharges itself mesad into the jugular vein.

With *Lepisosteus* the first in the chain of sinuses encircling the branchial cavity to connect anteriorly with the cephalic sinus is the branchial sinus. It lies between the branchial levator muscles and the skull, and collects the first three branchial trunks, the left branchial sinus receiving the dorsal lymphatic trunk. Posteriorly each branchial sinus is in connection with a spacious occipital sinus, which collects the lateral trunk from

the rear. Ventrad the occipital sinus communicates with the pericardial sinus; then passing mesad of the latter it again joins the pericardial sinus from below, after gathering in the pectoral sinus. The course of the pericardial sinus is along the inner and anterior margin of the clavicle, and shortly after receiving the ventral communication of the occipital sinus it is usually joined by a fork of the ventral lymphatic trunk. Occasionally, however, the ventral trunk does not divide, and in that case it empties directly into one or the other pericardial sinuses. Each pericardial sinus then continues cephalad along the side of the ventricle, immediately outside of the parietal layer of the pericardium, and when the bulbus is reached, sends inward a large communicating branch that terminates in the so-called dorsal pericardial sinus. This sinus, which is situated directly above the bulbus arteriosus, has one or two communications above with the inferior jugular, each orifice being guarded by a pair of semilunar valves opening into the vein.

The subcutaneous vessels surrounding the branchial cavity in *Polyodon* take on the form of canals rather than sinuses. Situated obliquely at the base of the skull is the hyo-opercularis sinus, which is formed from the union of the hyo-opercularis and facial trunks. The latter in the main follows the external jugular and its facialis branch, which in the region of the adductor mandibulæ muscles communicates through a lymphatic network with the so-called anterior facial lymphatic trunk. This vessel travels along the surface of these muscles and extends into the snout region. The hyo-opercularis sinus also receives the first branchial trunk, and opens mesad into a very large cephalic canal that runs along the branchial chamber directly above the jugular. The cephalic canal receives a great trunk from below, formed by the union of the second, third and fourth branchial vessels. When the supraclavicle is reached the cephalic canal tapers down into a sort of papilla preparatory to emptying into the cephalic sinus, and at this point it receives from below what is designated as the pericardial trunk. This vessel corresponds only in position to the pericardial sinuses of *Lepisosteus* and other fishes, and in no way is it suggestive of a sinus. In fact no pericardial sinuses were found in the region of the heart.

Strange to say, in *Polyodon* a great mass of lymphoid tissue surrounds the heart, which is supplied by the coronary blood vessels, and from which a lymphatic network arises that evidently reaches the veins through the medium of the œsophagus plexus.

Only in the caudal region of *Polyodon* were dorsal and ventral trunks found. They were present and extremely large in the thoracic region of *Lepisosteus;* while in *Polyodon* all of the subcutaneous vessels of the trunk were very minute.

EXPLANATION OF THE PLATES

PLATE I.

Figs. 1 to 17 were drawn to a scale from injected specimens: 18 to 21 are from microscopic preparations of injected material; and 22 to 27 are from sections. In general the arteries are stippled, the veins are cross-barred, and the so-called lymphatic trunks are drawn in outline. A vessel drawn in dotted outline signifies that it passes within or behind a bone, muscle or organ. All outlines for the microscopic drawings were made with a camera lucida and the details were filled in afterward.

FIG. 1. Represents a general lateral dissection of a 70-pound *Polyodon spathula* head as seen from the left side and above. Most of the paddle or spoon, all of the opercle and branchial arches, a part of the shoulder girdle, and the left wall of the brain case were removed so as to best portray the vessels. $\times \frac{1}{2}$.

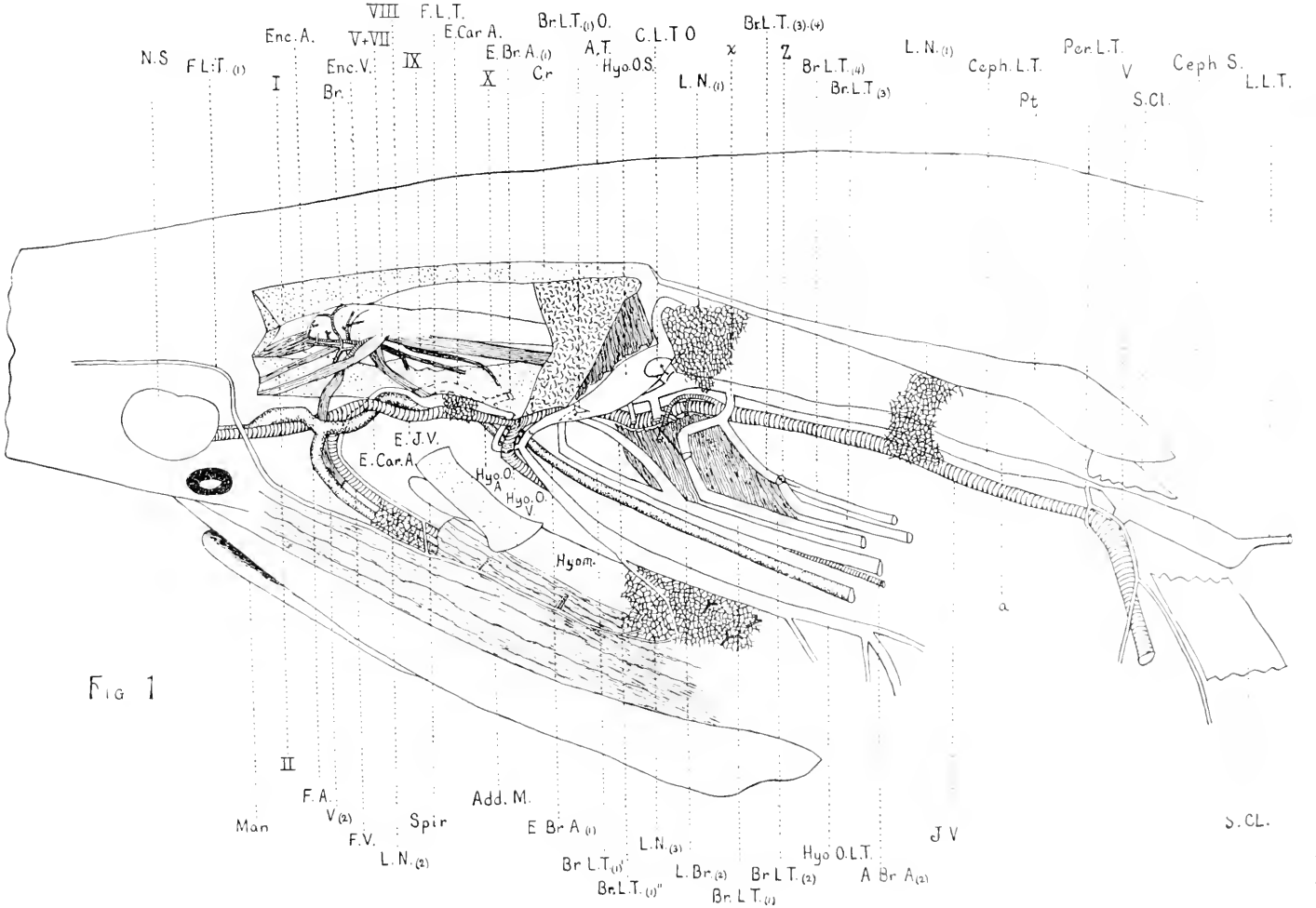

N.S
F.L.T.(1)
I
Enc.A.
Enc.V.
Br.
V+VII
VIII
F.L.T.
IX
E.Car.A.
X
E.Br.A.(1)
Cr
Br.L.T.(1) O.
A.T.
Hyo.O.S.
C.L.T.O
L.N.(1)
x
Br.L.T.(3)-(4)
Z
Br.L.T.(4)
Br.L.T.(3)
L.N.(1)
Ceph.L.T.
Pt
Por.L.T.
V
S.Cl.
Ceph S.
L.L.T.
E.J.V.
E.Car.A.
Hyo.O.A
Hyo.O.V
Hyom.
a
II
F.A.
V(2)
F.V.
L.N.(2)
Man
Spir
Add.M.
E.Br.A.(1)
Br.L.T.(1)'
Br.L.T.(1)''
L.N.(3)
L.Br.(2)
Br.L.T.(1)
Br.L.T.(2)
Hyo.O.L.T.
A.Br.A.(2)
J.V
S.CL.

FIG 1

PLATE II.

FIG. 2. Sketch of the principal trunks of a 25-pound *Polyodon* as seen from the left side. $\times \frac{3}{4}$.

Fig. 3. Same view and specimen as above, but seen from the opposite or right side.

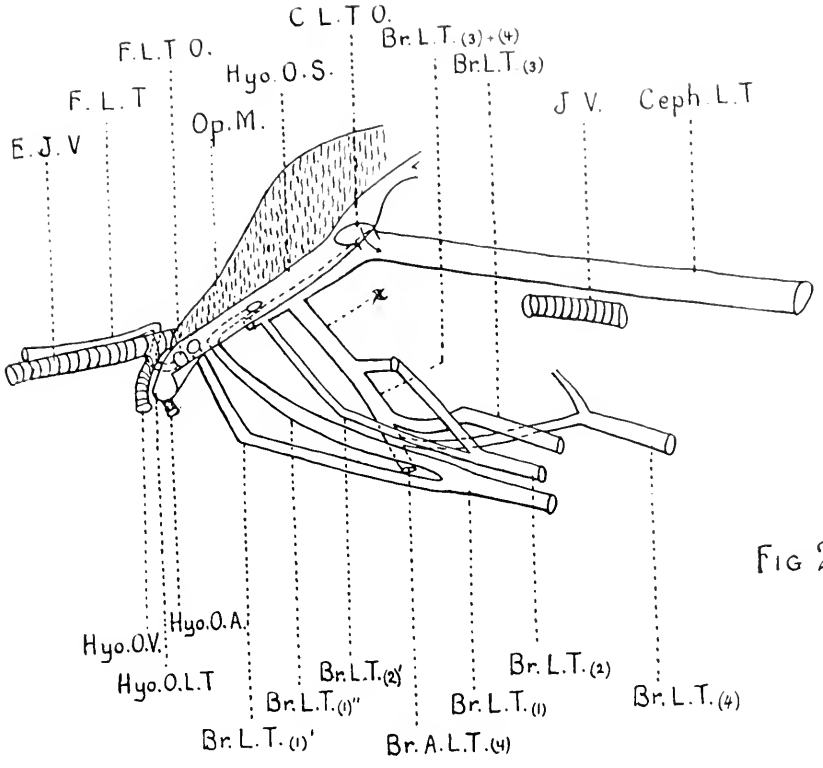

C.L.T.O.
F.L.T.O.
Hyo.O.S.
Br.L.T.(3)+(4)
Br.L.T.(3)
F.L.T
Op.M.
J.V.
Ceph.L.T
E.J.V
Hyo.O.V.
Hyo.O.A.
Hyo.O.L.T
Br.L.T.(2)'
Br.L.T.(2)
Br.L.T.(1)''
Br.L.T.(1)
Br.L.T.(4)
Br.L.T.(1)'
Br.A.L.T.(4)

FIG 2.

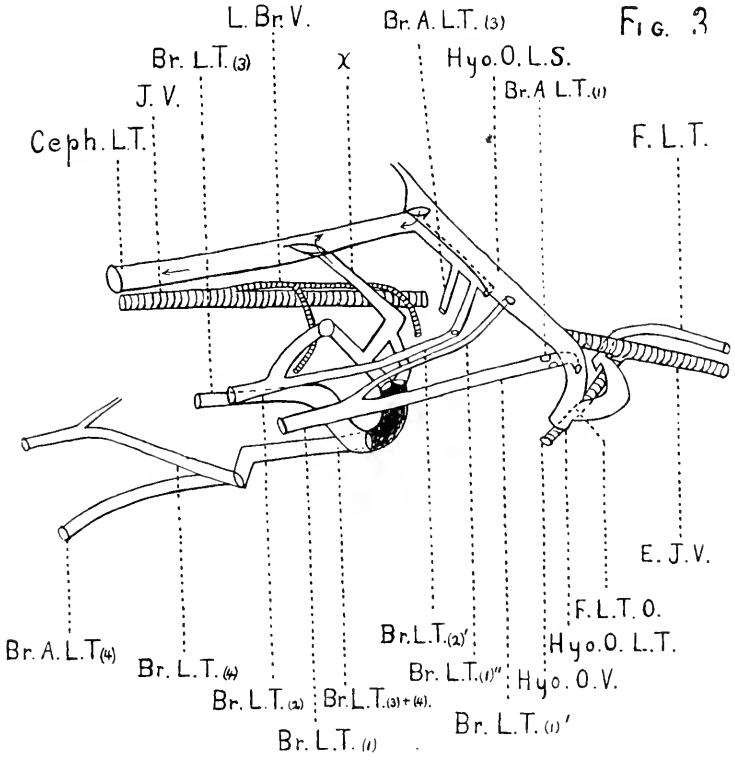

L.Br.V.
Br.A.L.T.(3)
Br.L.T.(3)
X
Hyo.O.L.S.
J.V.
Br.A.L.T.(1)
Ceph.L.T.
F.L.T.
E.J.V.
F.L.T.O.
Br.L.T.(2)'
Hyo.O.L.T.
Br.L.T.(1)''
Hyo.O.V.
Br.A.L.T.(4)
Br.L.T.(4)
Br.L.T.(2)
Br.L.T.(3)+(4).
Br.L.T.(1)'
Br.L.T.(1)

FIG. 3

PLATE III.

FIG. 4. Shows the course of the hyo-opercularis lymphatic trunk and its relations with the corresponding superficial branches of the hyo-opercularis artery and vein, as seen from the right side of a 15-pound *Polyodon*. $\times \frac{5}{6}$.

FIG. 5. Ventral view of the termination of the branchial lymphatic trunks (Nutrient branchial veins?) in the inferior jugular. 25-pound *Polyodon*. Natural size.

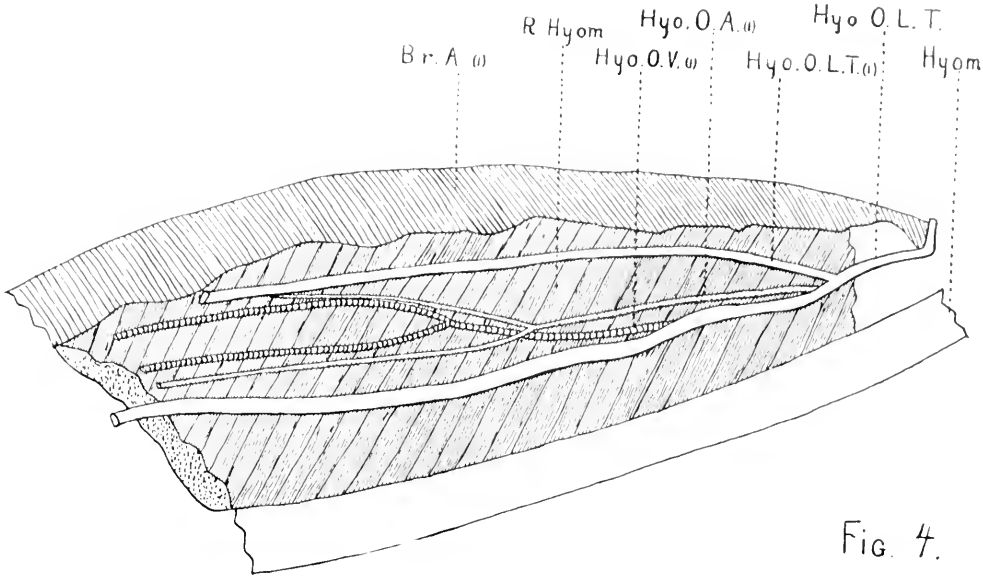

Br. A. (1)
R Hyom
Hyo. O. A. (1)
Hyo. O. V. (1)
Hyo. O. L. T. (1)
Hyo O. L. T.
Hyom

FIG. 4.

FIG. 5.

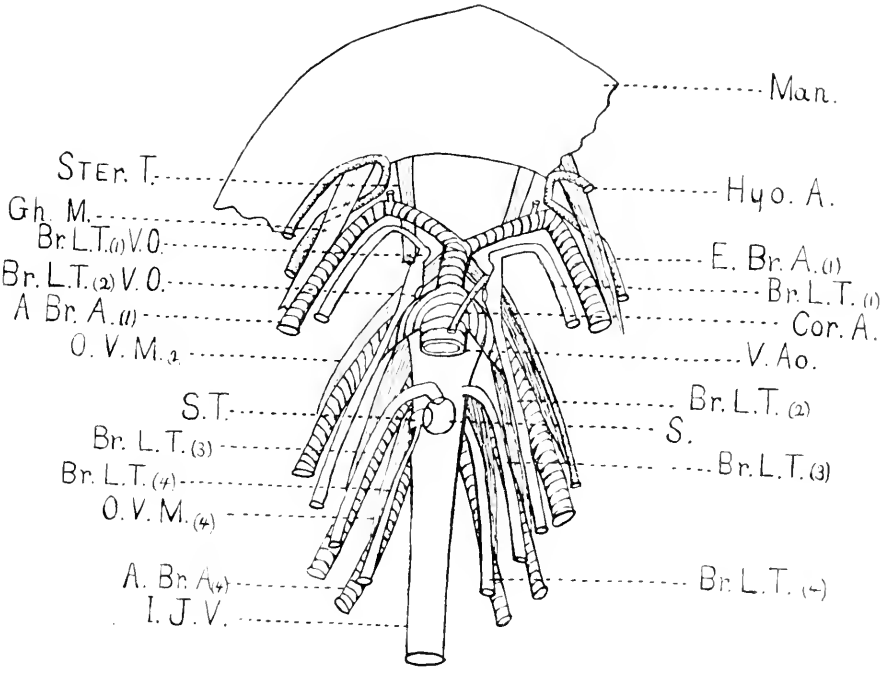

Man.
STER. T.
Hyo. A.
Gh. M.
Br. L. T. (1) V. O.
E. Br. A. (1)
Br. L. T. (2) V. O.
Br. L. T. (1)
A Br. A. (1)
Cor. A.
O. V. M. (2)
V. Ao.
S. T.
Br. L. T. (2)
S.
Br. L. T. (3)
Br. L. T. (3)
Br. L. T. (4)
O. V. M. (4)
A. Br. A. (4)
Br. L. T. (4)
I. J. V.

PLATE IV.

FIG. 6. Deeper dissection of the same specimen as above.

FIG. 7. Similar view and dissection as 6 of a 10-pound *Polyodon*. Natural size.

FIG. 6.

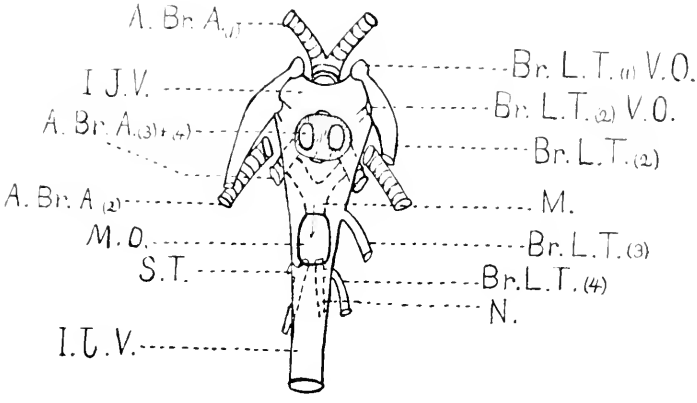

A. Br. A.(1)
I.J.V.
A. Br. A.(3)+(4)
A. Br. A.(2)
M.O.
S.T.
I.U.V.
Br. L.T.(1) V.O.
Br. L.T.(2) V.O.
Br. L.T.(2)
M.
Br. L.T.(3)
Br. L.T.(4)
N.

FIG. 7.

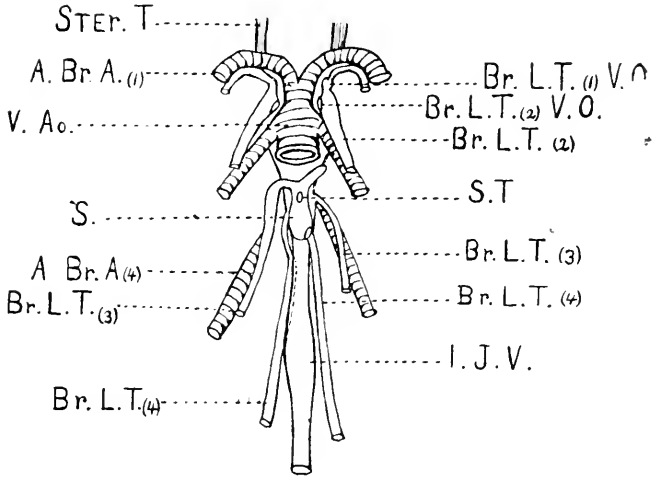

STER. T.
A. Br. A.(1)
V. Ao.
S.
A. Br. A.(4)
Br. L.T.(3)
Br. L.T.(4)
Br. L.T.(1) V.O.
Br. L.T.(2) V.O.
Br. L.T.(2)
S.T.
Br. L.T.(3)
Br. L.T.(4)
I.J.V.

PLATE V.

FIG. 8. Is from a general lateral dissection of a small *Lepisosteus tristœchus* as seen from the left side. Most of the opercular and shoulder girdle regions removed. $\times \frac{4}{5}$.

FIG. 9. Diagram of the left pericardial sinus and connections from a 10-pound *Lepisosteus osseus*. $\times \frac{2}{3}$.

FIG. 10. Same specimen as above, showing opposite or right pericardial sinus. $\times \frac{2}{3}$.

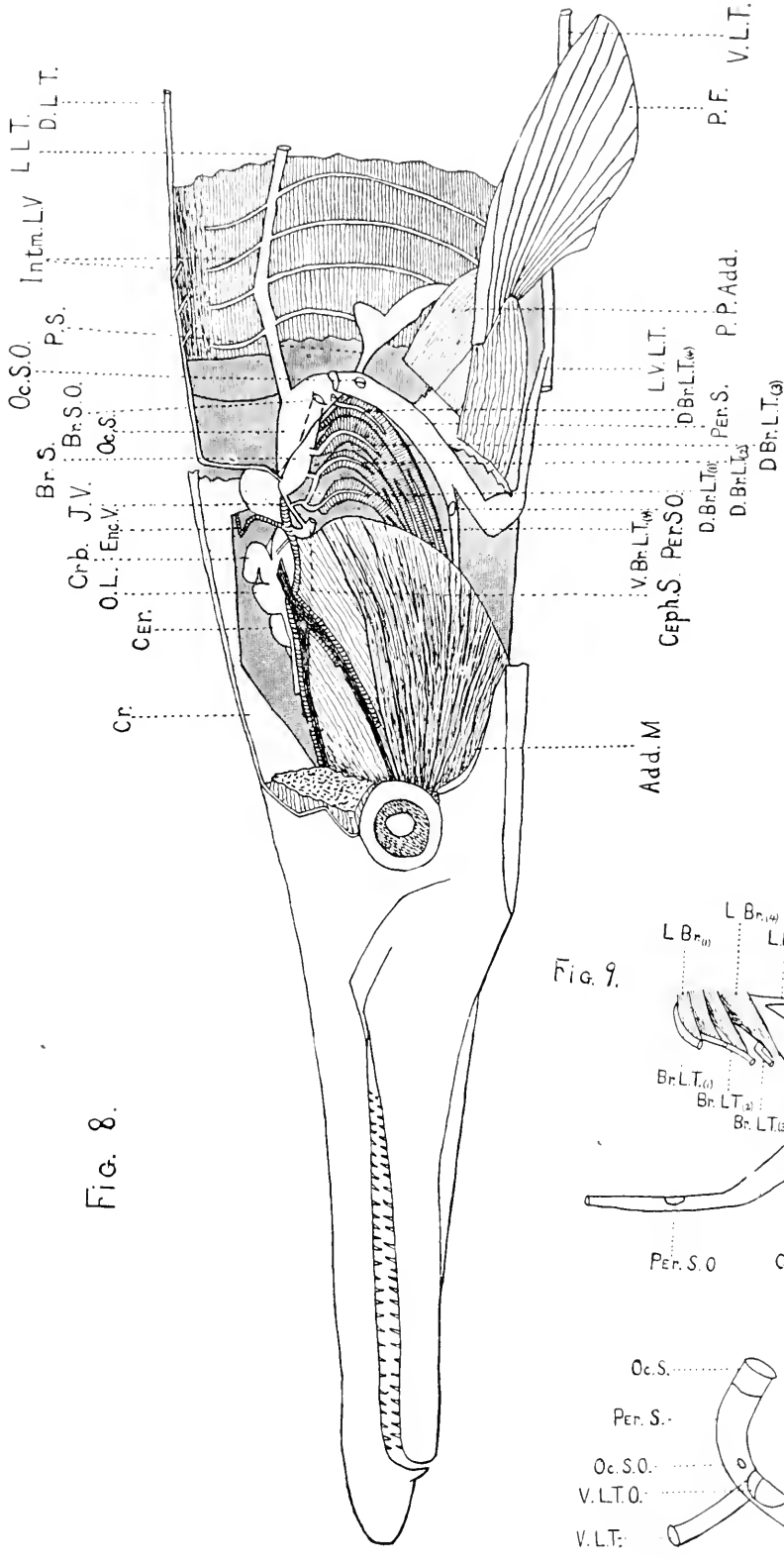
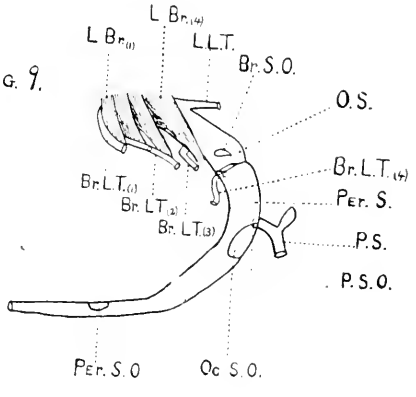


Fig. 8.

Fig. 9.



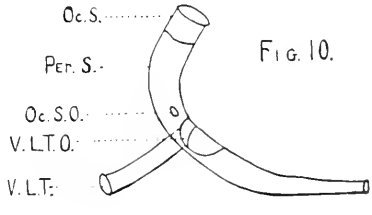


Fig. 10.

PLATE VI.

FIG. 11. Dorsal view of the same *Lepisosteus tristœchus* as Fig. 8. The dissection on the left side is carried considerably deeper than the right. Shows especially the termination of the cephalic lymphatic trunks in the cephalic sinus, and the communication of the latter with the jugular vein. $\times \frac{2}{3}$.

FIG. 12. Similar view to Fig. 11 of a 10-pound *Lepisosteus osseus*. Right side not figured. $\times \frac{2}{3}$.

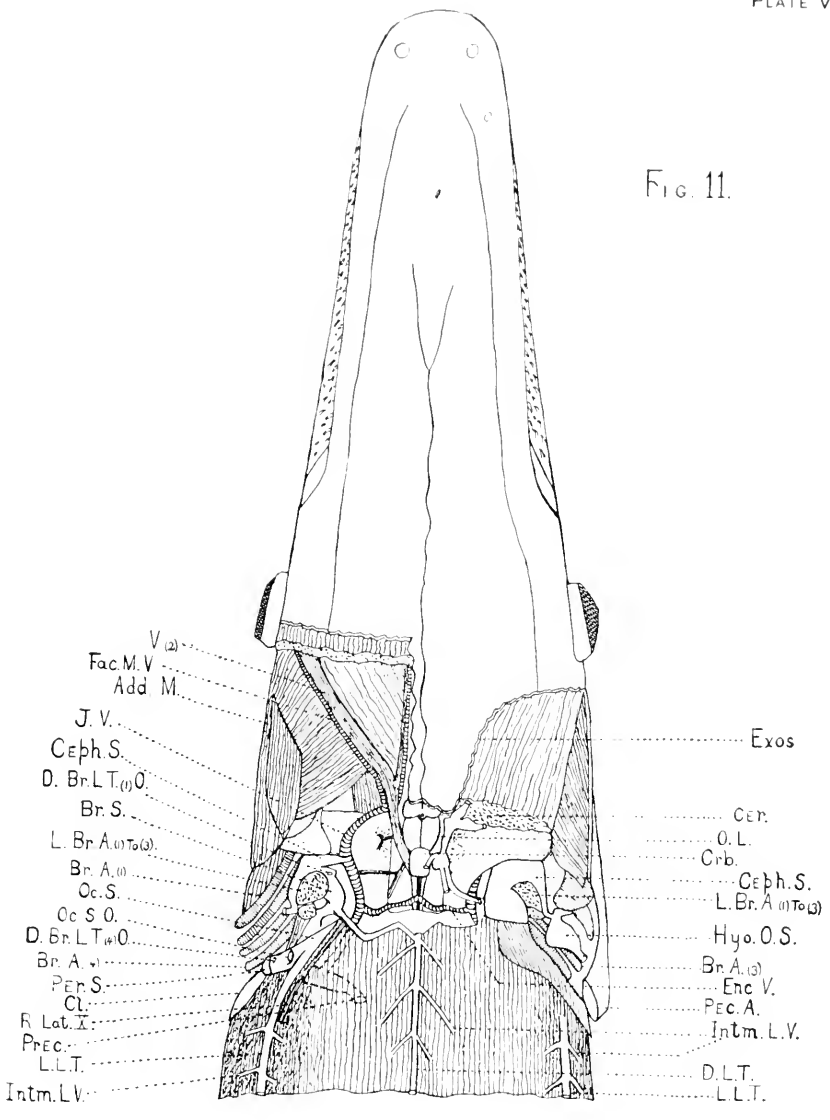

V (2)
Fac. M. V
Add M.
J. V.
Ceph. S.
D. Br. L. T. (1) O.
Br. S.
L. Br. A. (1) To (3).
Br. A. (1)
Oc. S.
Oc. S. O.
D. Br. L. T. (4) O.
Br. A. (4)
Per. S.
Cl.
R. Lat. X.
Prec.
L. L. T.
Intm. L. V.
Exos
Cer.
O. L.
Crb.
Ceph. S.
L. Br. A. (1) To (3)
Hyo. O. S.
Br. A. (3)
Enc. V.
Pec. A.
Intm. L. V.
D. L. T.
L. L. T.

Fig. 11.

Fig. 12.

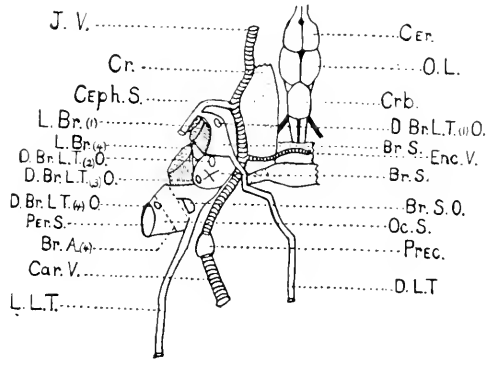

J. V.
Cr.
Ceph. S.
L. Br. (1)
L. Br. (4)
D. Br. L. T. (2) O.
D. Br. L. T. (3) O.
D. Br. L. T. (4) O.
Per. S.
Br. A. (4)
Can. V.
L. L. T.
Cer.
O. L.
Crb.
D. Br. L. T. (1) O.
Br. S.
Enc. V.
Br. S.
Br. S. O.
Oc. S.
Prec.
D. L. T

PLATE VII.

FIG. 13. Ventral view of the same *Lepisosteus tristœchus* as Figs. 8 and 11. Shows the termination of the ventral lymphatic trunk in the pericardial sinuses and the union of the latter in a dorsal pericardial sinus, which lies directly above the bulbus arteriosus and communicates with the inferior jugular above. $\times \frac{3}{4}$.

FIG. 13

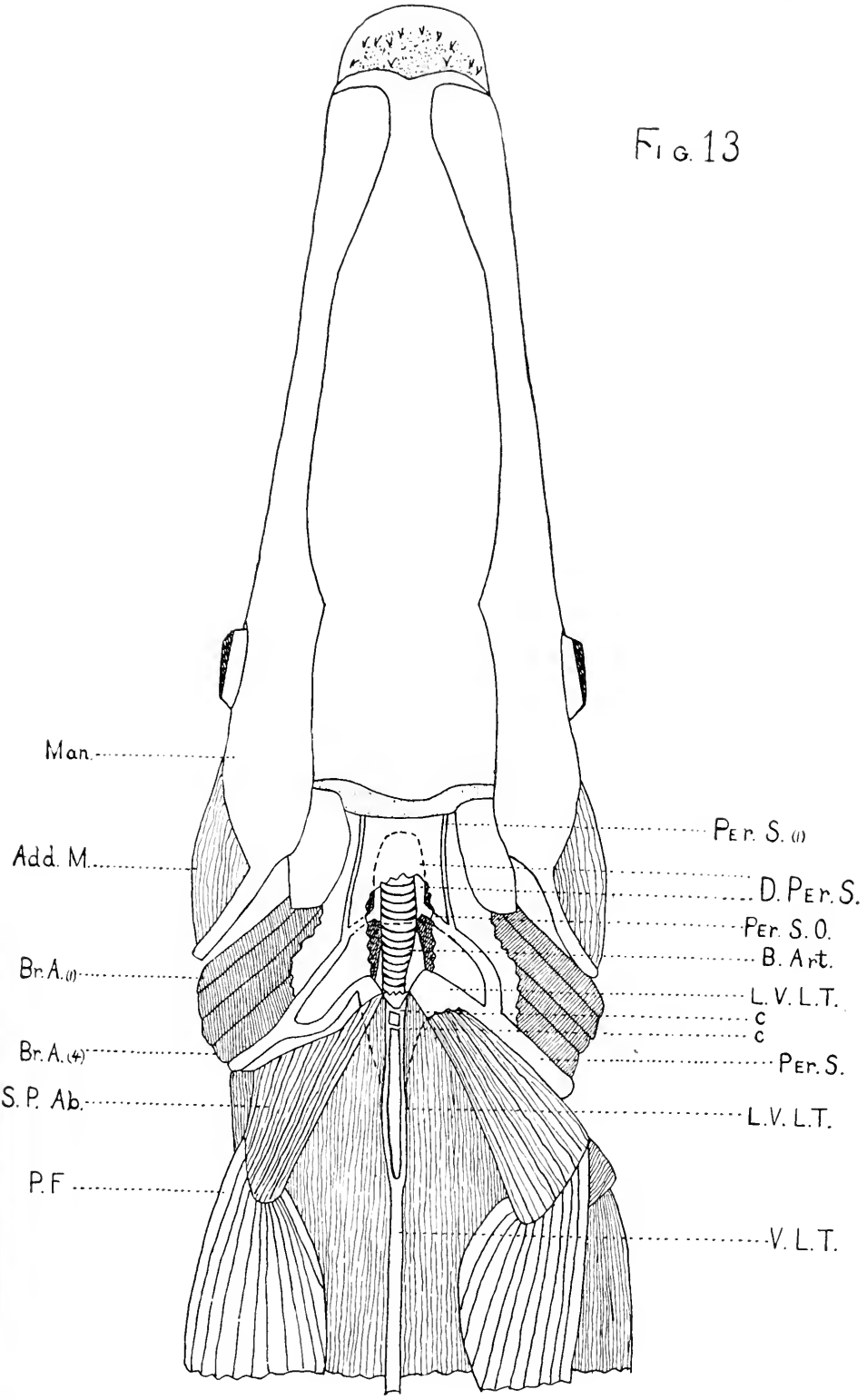

Man.
Add. M.
Br. A. (1)
Br. A. (4)
S. P. Ab.
P. F
Per. S. (1)
D. Per. S.
Per. S. O.
B. Art.
L. V. L. T.
C
C
Per. S.
L. V. L. T.
V. L. T.

PLATE VIII.

FIG. 14. Represents a dissection of a 10-pound *Lepisosteus osseus* in the region of the heart as seen from the ventral side. Ventral walls of the lymphatic sinuses and the right inferior jugular removed to show the union of the ventral lymphatic trunk with the right pericardial sinus, the orifice of the latter which communicates with the dorsal pericardial sinus, and the termination of the two anterior branchial lymphatic trunks (nutrient branchial veins?) in the right fork of the inferior jugular. $\times \frac{5}{6}$.

FIG. 15. Is a deeper dissection of the same specimen as 14. Heart, ventral aorta, most of the efferent branchial vessels, and the ventral walls of the lymphatic sinuses and inferior jugular removed to show the points of termination of the branchial lymphatic trunks (nutrient branchial veins?) in the inferior jugular, the pericardial sinuses in the dorsal pericardial sinus, its connections with the inferior jugular above, and finally the discharging of the inferior jugular in the sinus venosus. $\times \frac{6}{7}$.

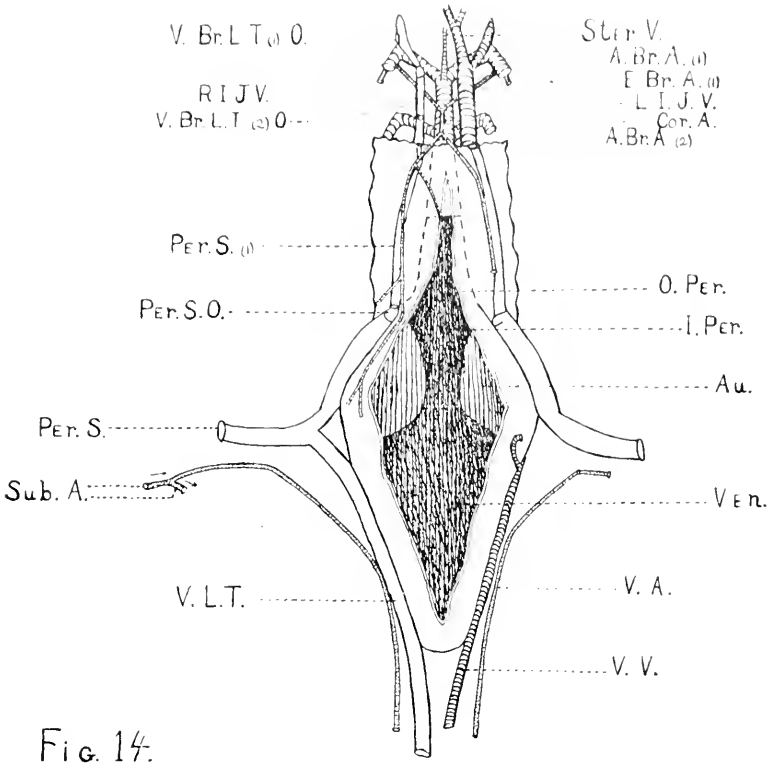

V. Br. L. T. (1) O.
R. I. J. V.
V. Br. L. T. (2) O.
Ster. V.
A. Br. A. (1)
E. Br. A. (1)
L. I. J. V.
Cor. A.
A. Br. A. (2)
Per. S. (1)
Per. S. O.
Per. S.
Sub. A.
V. L. T.
O. Per.
I. Per.
Au.
Ven.
V. A.
V. V.

Fig. 14.

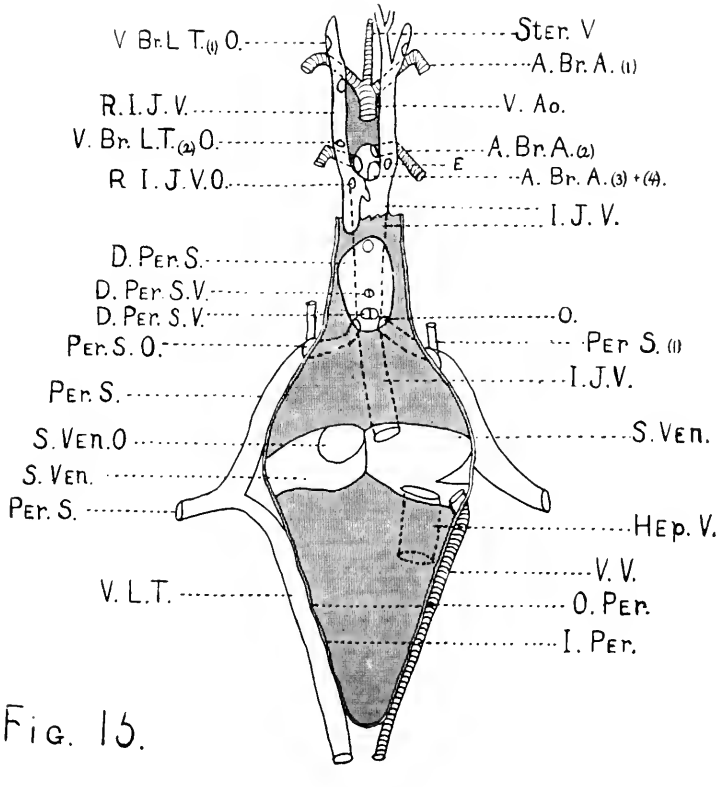

V. Br. L. T. (1) O.
R. I. J. V.
V. Br. L. T. (2) O.
R. I. J. V. O.
D. Per. S.
D. Per. S. V.
D. Per. S. V.
Per. S. O.
Per. S.
S. Ven. O
S. Ven.
Per. S.
V. L. T.
Ster. V
A. Br. A. (1)
V. Ao.
A. Br. A. (2)
A. Br. A. (3) + (4).
I. J. V.
O.
Per. S. (1)
I. J. V.
S. Ven.
Hep. V.
V. V.
O. Per.
I. Per.

Fig. 15.

PLATE IX.

FIG. 16. Transverse section through a rather small *Lepisosteus osseus* taken 33 mm. behind the opercle as seen from the rear. Shows the main longitudinal lymphatic trunks in section. Natural size.

FIG. 16*a*. Transverse through the ventral lymphatic trunk region 20 mm. caudad of Fig. 16 as seen from the rear. Natural size.

FIG. 16*b*. Transverse section through the ventral lymphatic trunk region 20 mm. cephalad of 16 as seen from the rear. Note the trunk is curving off to the right preparatory to emptying into the right pericardial sinus. Natural size.

FIG. 17. Represents the inner or posterior surface of the first branchial arch of a 70-pound *Polyodon*. Except at the two extremities the gill rakers are cut at their bases so as to best display the branching of the lymphatics (veins?) over the surface of the arch. At one place a few of the inner branchial filaments are removed to show the position of the branchial lymphatic trunk (nutrient branchial vein?) in relation to the afferent and efferent branchial trunks. Preceding this gap the filament lymphatic network (nutrient venous network?) is indicated on the outer surface of several of the filaments. $\times \frac{1}{2}$.

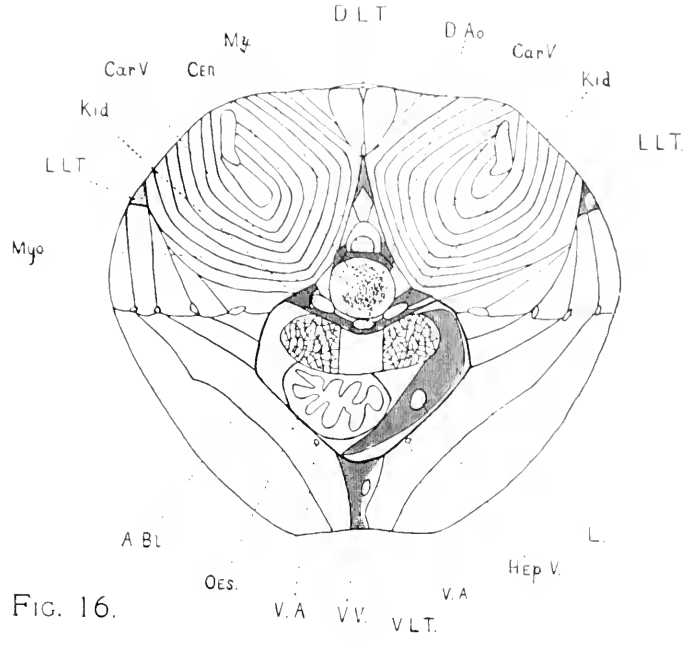


FIG. 16.

FIG. 16a.

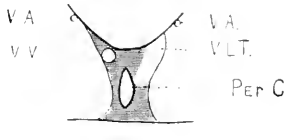


FIG. 16b.

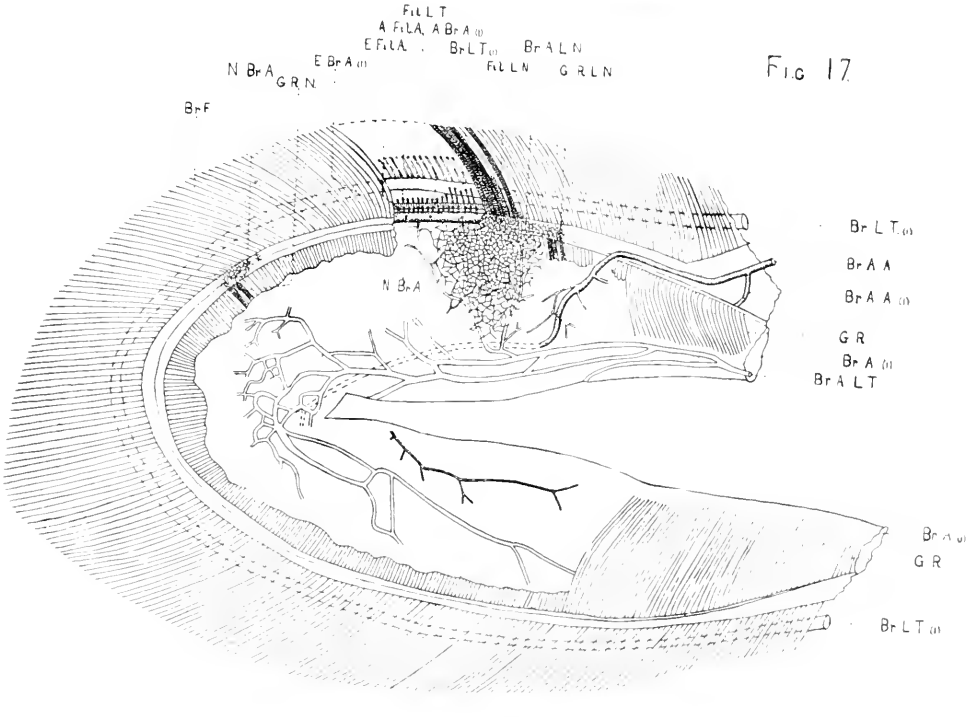


FIG. 17

PLATE X.

FIG. 18. Microscopic preparation of an injected branchial filament of a 70-pound *Polyodon* as seen from above. The respiratory filament vessels are stippled and the lymphatic network (nutrient filament veins?), which are shown only in part, are drawn in outline. × 50. Reduced $\frac{1}{5}$.

FIG. 18*a*. A portion of the filament respiratory network. × 450. Reduced $\frac{1}{5}$.

FIG. 19. Dorsal view of the lymphatic (nutrient venous?) network of a 70-pound *Polyodon*. This network is superficial to the septa that contains the respiratory network, and for the most part the transverse vessels run parallel to the spaces separating the respiratory septa. Its meshes are more irregular and very much coarser (compare with Fig. 18). A longitudinal filament lymphatic trunk (nutrient filament vein?) receives the network from the two opposite filaments. × 50. Reduced $\frac{2}{5}$.

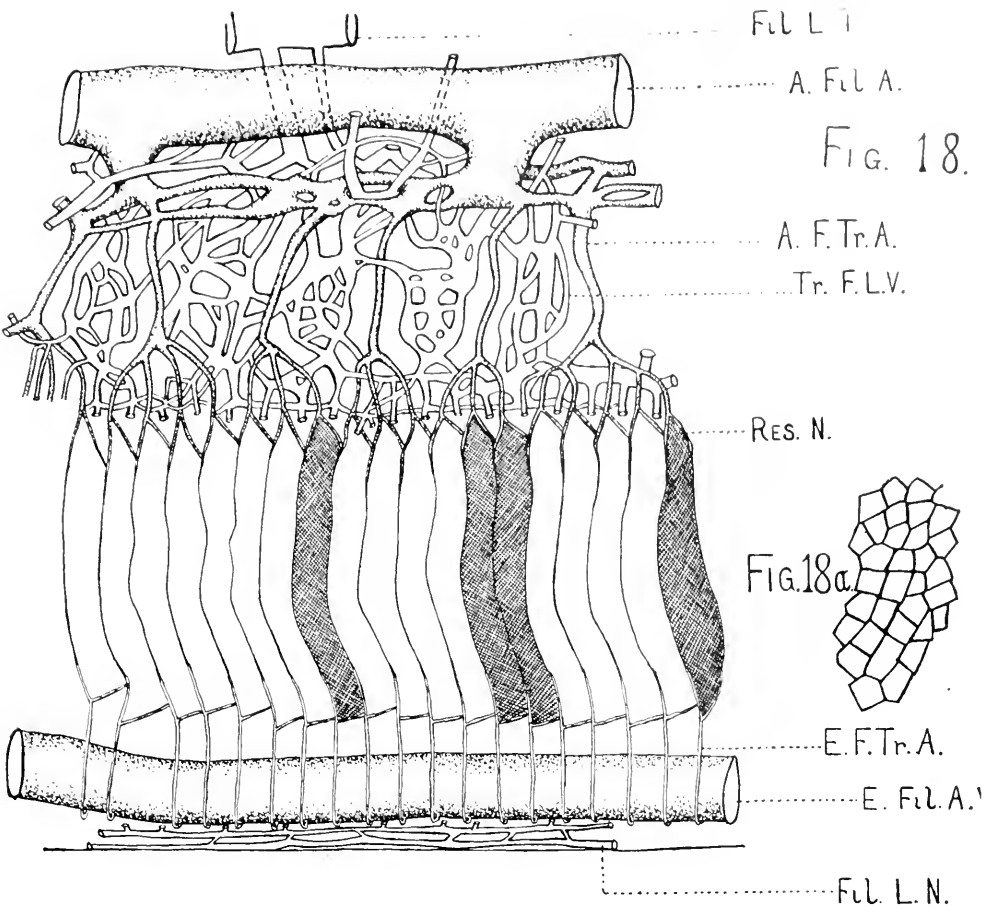


Fig. 18.

Fig. 18a.

Fig 19.

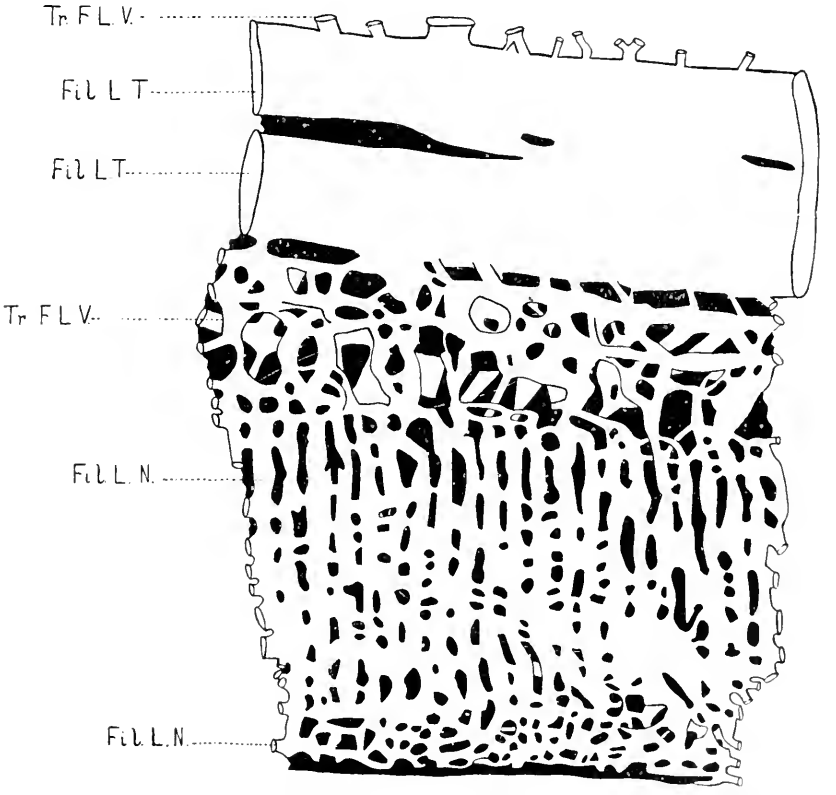


PLATE XI.

FIG. 20. A portion of the outer surface of a branchial arch of a 70-pound *Polyodon* at the base of two filaments. The main efferent branchial artery, which lies directly below the efferent filament arteries is not figured. The efferent filament and the nutrient arteries are stippled; while the branchial and filament lymphatics (nutrient veins?) are drawn in outline. × 50. Reduced ½.

FIG. 21. Like Fig. 19, a dorsal view of the same filament taken nearer the basal end of the filament. Introduced to show the character of the so-called lymphatic network on the outer edge of the filament. × 50. Reduced ½.

FIG. 20.

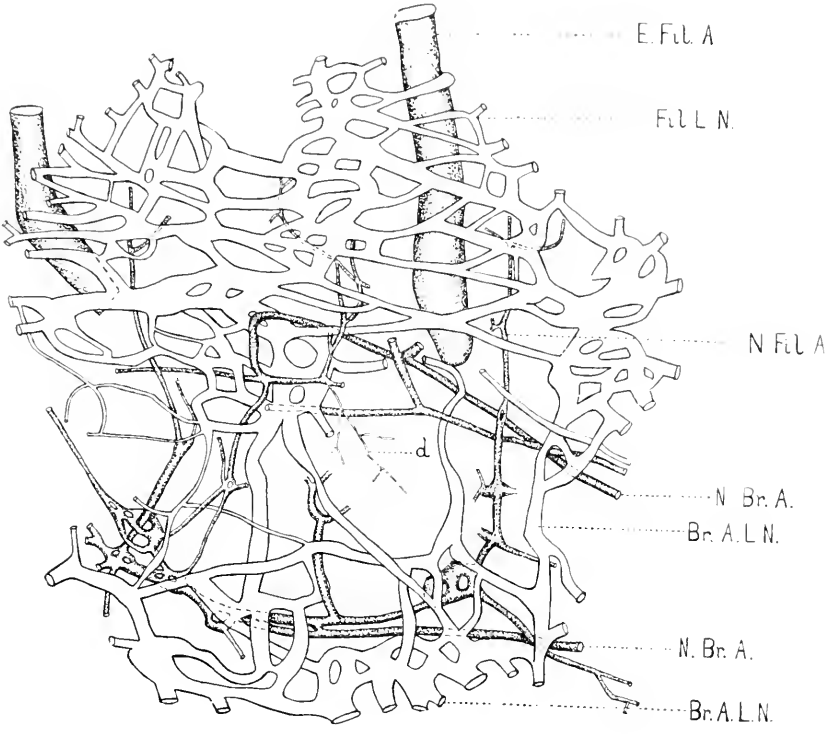


FIG. 21.

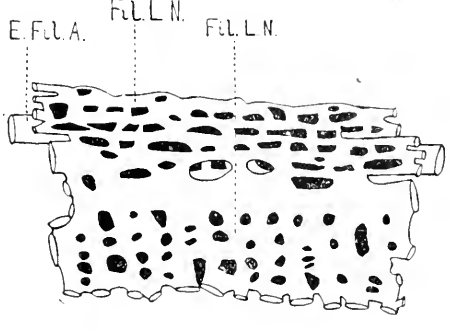


PLATE XII.

FIG. 22. Portion of a longitudinal section through the so-called cephalic lymphatic trunk of a 15-inch *Polyodon*. Note the papilla and the relative proportion of white corpuscles to red. × 450. Reduced $\frac{3}{5}$.

FIG. 23. Transverse section through the jugular vein of a 15-inch *Polyodon*. Note papilla here also and that the red corpuscles predominate. Outline surrounding some of the corpuscles denotes plasma boundary. × 450. Reduced $\frac{1}{4}$.

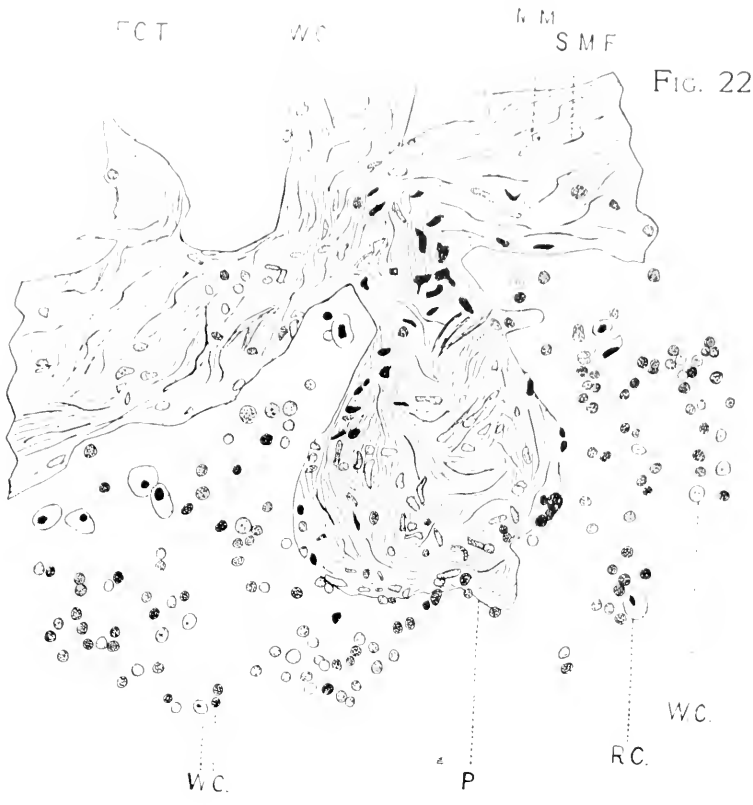


FIG. 22.

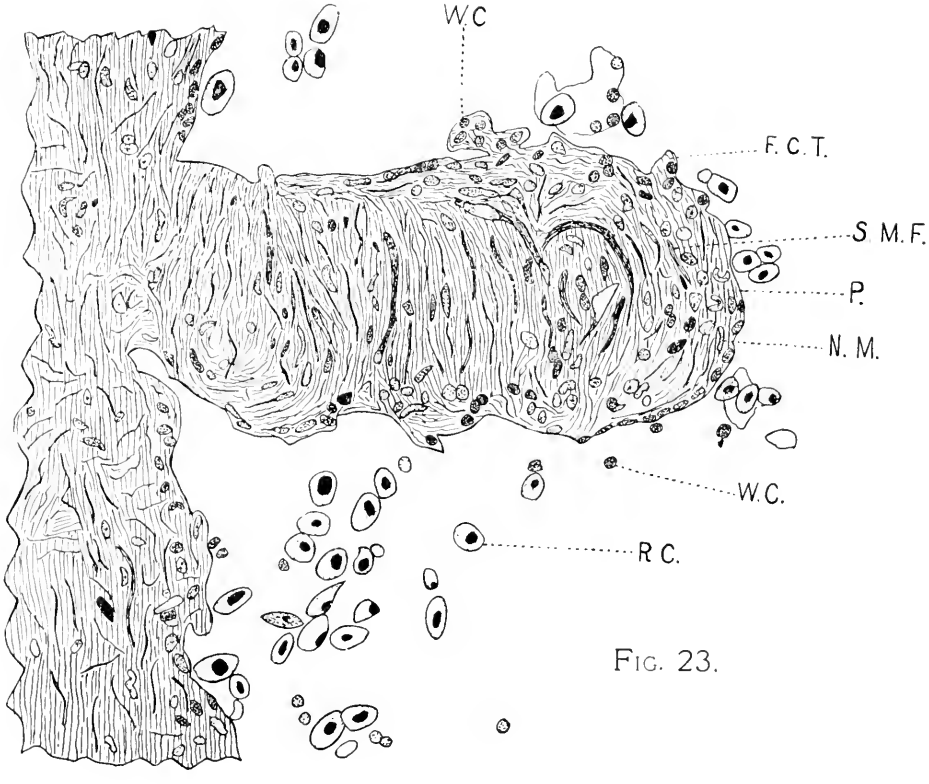


FIG. 23.

PLATE XIII.

FIG. 24. Transverse section through the so-called hyo-opercularis lymphatic trunk of a 15-inch *Polyodon*. The section is taken through a papilla near its surface. In this trunk the white corpuscles, although very scarce, greatly predominate over the red. × 450. Reduced $\frac{2}{7}$.

FIG. 25. Similar section to 24 through the hyo-opercularis artery. × 450. Reduced $\frac{2}{7}$.

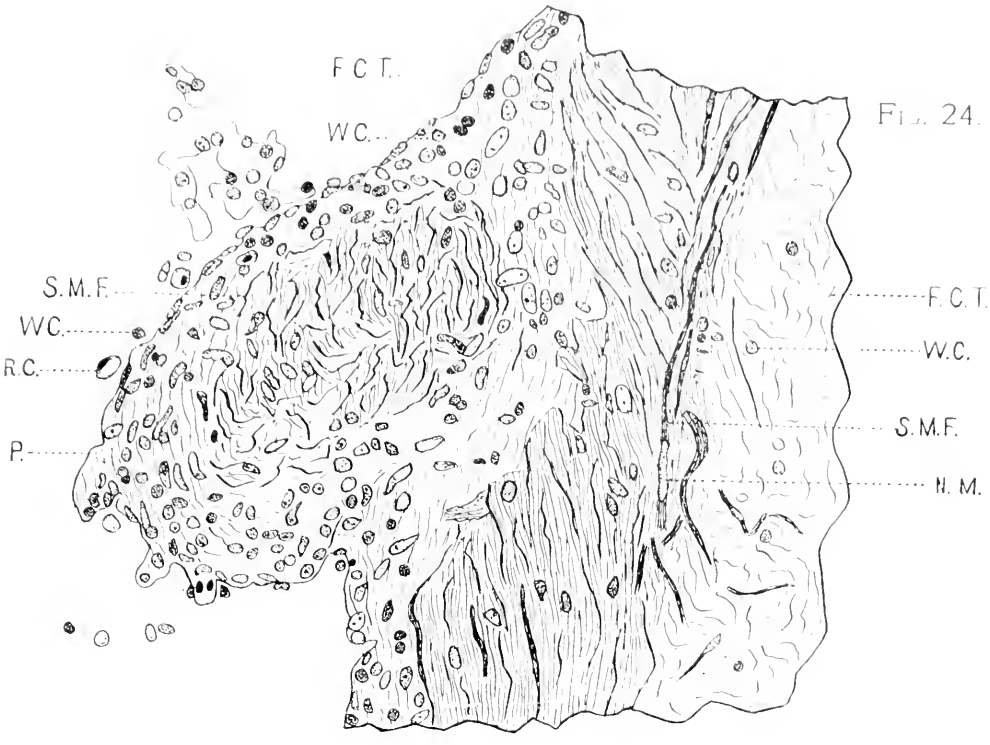


FIG. 24.

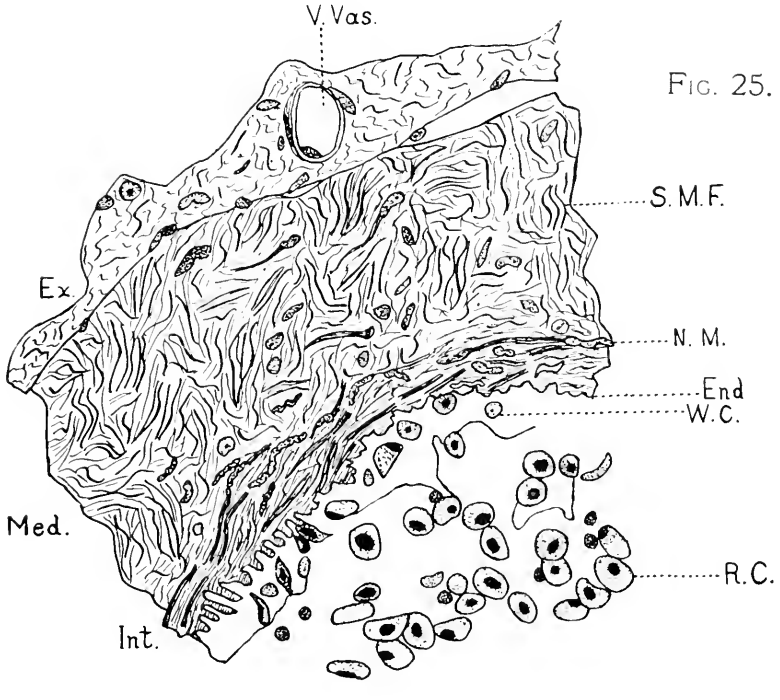


FIG. 25.

PLATE XIV.

FIG. 26. Similar section to 24 through the hyo-opercularis vein. Structure is very similar to the lymphatic trunk, but the red corpuscles greatly predominate. $\times 450$. Reduced $\frac{1}{5}$.

FIG. 27. A diagrammatic transverse section through three pairs of branchial filaments of *Polyodon*.

FIG. 26.

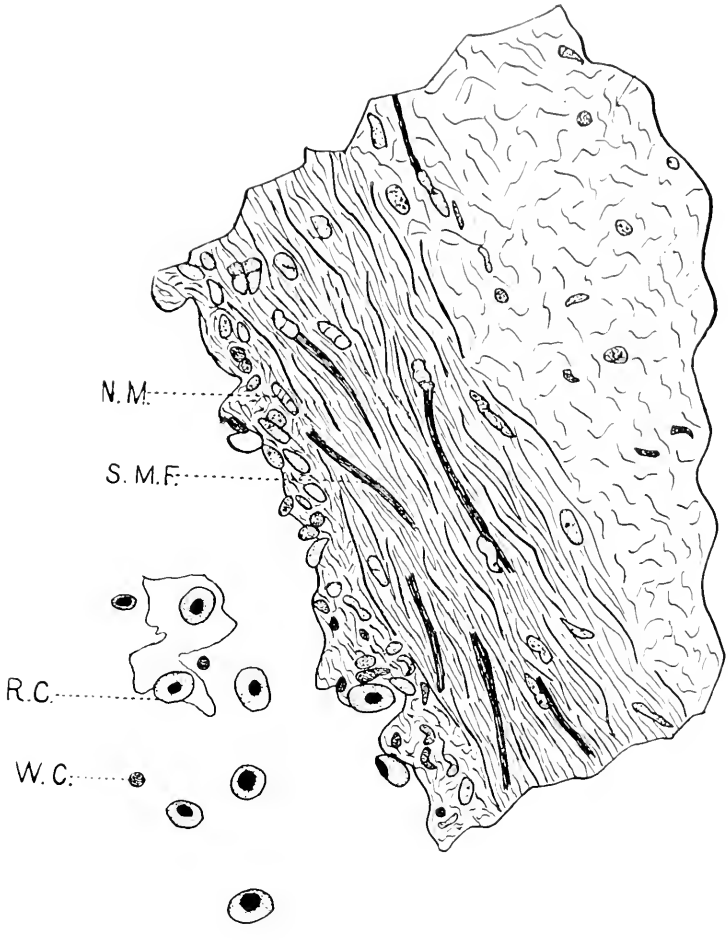


FIG. 27.

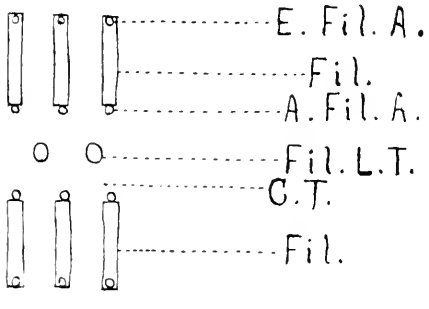
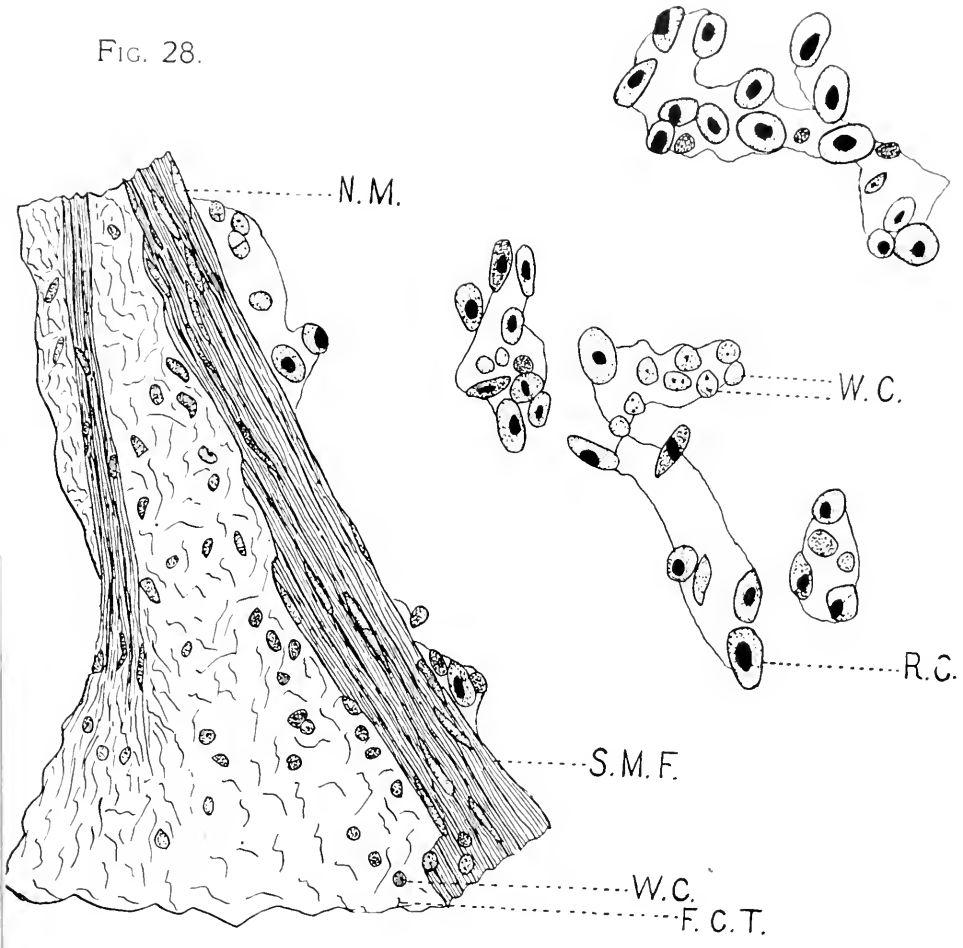


PLATE XV.

FIG. 28. Is a transverse section through the branchial lymphatic trunk (nutrient branchial vein?) of a 15-inch *Polyodon*. Note the predominance of red corpuscles. In another portion of the section the wall is much thinner. × 450. Reduced $\frac{1}{20}$.

FIG. 28.



VI. LIST OF ABBREVIATIONS USED IN THE FIGURES.

A or *P* prefixed to an abbreviation signifies anterior or posterior: *R* or *L*. right or left; a series is numbered from cephalad to caudad.

a.	In Fig. 1 point where injections were made with *Polyodon*.
A.Bl.	Air-bladder.
A.Br.A.(1)-(4).	Afferent branchial arteries 1 to 4.
Add.M.	Adductor mandibulæ muscles.
A.Fil.A.	Afferent filament arteries.
A.F.Tr.A.	Afferent filament transverse arteries.
A.T.	Adipose tissue in brain cavity.
Au.	Auricle.
B.Art.	Bulbus arteriosus.
Br.A.(1)-(4).	Branchial arches 1 to 4.
Br.A.A.	Branchial arch artery.
Br.A.A.(1).	Branchial arch artery for outer surface of arch.
Br.A.L.N.	Branchial arch lymphatic (venous?) network.
Br.A.L.T.	Branchial arch lymphatic trunk (nutrient branchial vein?).
Br.F.	Branchial filaments.
Br.L.T.(1)-(4).	Branchial lymphatic trunks (nutrient branchial veins?) 1–4.
Br.L.T.(3) and (4).	Combined trunk formed by the union of the third and fourth branchial lymphatic vessels.
Br.L.T.(1′).	Ventral fork of the first branchial lymphatic trunk.
Br.L.T.(1″).	Dorsal fork of the first branchial lymphatic trunk.
Br.L.T.(2′).	Ventral fork of the second branchial lymphatic trunk.
Br.L.T.(1)*O.*	Opening of branchial lymphatic trunk (1) into the hyo-opercularis sinus, *Polyodon*.
Br.L.T.(1)*V.O.*	Opening of the first ventral branchial trunk in the inferior jugular.
Br.S.	Branchial sinus. *Lepisosteus*.
Br.S.O.	Branchial sinus opening into the pericardial sinus.
c.	Communications between the 2 forks of the ventral trunk.
Car.V.	Cardinal vein.
Cen.	Centrum.
Ceph.L.T.	Cephalic lymphatic trunk, *Polyodon*.
Ceph. S.	Cephalic sinus.
Cer.	Cerebrum.
Cl.	Clavicle.
C.L.T.O.	Cephalic trunk opening into hyo-opercularis sinus in *Polyodon*.
Cor. A.	Coronary artery.
Cr.	Cranial wall.
Crb.	Cerebellum.
C.T.	Connective tissue.
d.	In Fig. 20 capillary from nutrient branchial artery.
D.Ao.	Dorsal aorta.

D.Br.L.T.(1)-(4).	Dorsal branchial lymphatic trunks (nutrient branchial veins ?) 1 to 4, *Lepisosteus.*
D.Br.L.T.(1)-(4)*O.*	Dorsal branchial trunk openings into the branchial and occipital sinuses, *Lepisosteus.*
D.L.T.	Dorsal lymphatic trunk.
D.Per.S.	Dorsal pericardial sinus, *Lepisosteus.*
D.Per.S.V.	Semilunar valves of the dorsal pericardial sinus of *Lepisosteus* opening into the inferior jugular.
E.Br.A.(1)-(4).	Efferent branchial arteries 1 to 4.
E.Fil.A.	Efferent filament arteries.
E.F.Tr.A.	Efferent filament transverse arteries.
Enc.A.	Encephalic artery.
Enc.V.	Encephalic vein.
End.	Endothelium.
Ex.	Tunica externa (adventitia).
Exos.	Exoskeleton.
F.A.	Facialis artery.
Fac.M.V.	Facialis-mandibularis vein.
F.C.T.	Fibrous connective tissue.
Fil.	Filament.
Fil.L.N.	Filament lymphatic (nutrient venous?) network.
Fil.L.T.	Filament lymphatic trunk (nutrient filament vein?).
F.L.T.	Facial lymphatic trunk.
F.L.T.(1).	Anterior facial lymphatic trunk.
F.L.T.O.	Facial lymphatic trunk opening into the hyo-opercularis sinus.
F.V.	Facialis vein.
Gh.M.	Glossohaly muscle.
G.R.	Gill rakers.
G.R.L.N.	Gill raker lymphatic (venous?) network.
G.R.N.	Gill raker arterial network.
Hep.V.	Hepatic vein.
Hyo.A.	Hyoidean artery.
Hyom.	Hyomandibular.
Hyo.O.A.	Hyo-opercularis artery.
Hyo.O.A.(1).	Superficial branch of the hyo-opercularis artery.
Hyo.O.L.T.	Hyo-opercularis lymphatic trunk.
Hyo.O.L.T.(1).	Dorsal branch of the hyo-opercularis lymphatic trunk.
Hyo.O.S.	Hyo-opercularis sinus, *Lepisosteus.*
Hyo.O.V.	Hyo-opercularis vein.
Hyo.O.V.(1).	Superficial branch of the hyo-opercularis vein.
I.J.V.	Inferior jugular vein.
Int.	Tunica intima.
Intm.L.V.	Intermuscular or transverse lymphatic vessels.
I.Per.	Visceral or inner layer of the pericardium.
J.V.	Jugular vein.
Kid.	Kidney.
L.	Liver.
L.Br.(1)-(4).	Branchial levator muscles 1 to 4.
L.Br.V.	Branchial levator muscle veins.

L.I.J.V.	Left fork of the inferior jugular vein.
L.L.T.	Lateral lymphatic trunk.
L.N.(1).	Lymphatic network on surface of the thymus gland and adjacent region, *Polyodon*.
L.N.(2).	Lymphatic network overlying the facialis blood vessels, *Polyodon*.
L.N.(3).	Lymphatic network in hyo-opercularis region of *Polyodon*.
L.V.L.T.	Left fork of the ventral lymphatic trunk.
M.	Dorsal sinus emptying into the inferior jugular, *Polyodon*.
Man.	Mandible.
Med.	Tunica media.
M.O.	Orifice of the dorsal sinus opening into the inferior jugular, *Polyodon*.
My.	Myelon.
Myo.	Myotomes.
N.	Posterior sacs of *Polyodon* that terminate in the inferior jugular.
N.Br.A.	Nutrient branchial arteries.
N.Fil.A.	Nutrient filament arteries.
N.M.	Nucleus smooth muscle.
N.S.	Nasal sac.
o.	In Fig. 15 orifice of pericardial sinus leading into the dorsal pericardial sinus.
Oc.S.	Occipital sinus, *Lepisosteus*.
Oc.S.O.	Occipital sinus opening into the pericardial sinus.
Œs.	Œsophagus.
O.L.	Optic lobes.
O.Per.S.	Parietal or outer layer of the pericardium.
Op.M.	M. Opercularis.
O.V.M.(1)-(4).	Obliqui ventrales muscles 1 to 4.
P.	Papilla.
Pec.A.	Pectoral arch.
Per.C.	Pericardial cavity.
Per.L.T.	Pericardial lymphatic trunk, *Polyodon*.
Per.S.	Pericardial sinus, *Lepisosteus*.
Per.S.(1).	Anterior continuation of the pericardial sinus.
Per.S.O.	Communications of the pericardial sinuses with the dorsal pericardial sinus.
P.F.	Pectoral fin.
P.P.Add.	Pectoral profundus adductor muscle.
Prec.	Precava.
Prem.	Premaxilla.
P. S.	Pectoral sinus.
P.S.O.	Pectoral sinus emptying into the occipital sinus.
Pt.	Post-temporal.
R.C.	Red corpuscle.
Res.N.	Respiratory network.
R.Hyom.	Retractor hyo-mandibularis muscle.
R.I.J.V.	Right fork of the inferior jugular vein.
R.I.J.V.O.	Right fork of the inferior jugular opening into the inferior jugular.

R.Lat.N.	Ramus lateralis vagi.
S.	A sinus in *Polyodon*, which lies above the ventral aorta and opens into the inferior jugular above.
S.Cl.	Supra-clavicle.
S.M.F.	Smooth muscle fiber.
S.P.Abd.	Superficial pectoral abductor muscle.
Spir.	Spiracle.
S.T.	Communicating trunk from sinus *S* to inferior jugular.
Ster.T.	Sterno-hyoideus tendon.
Ster.V.	Sterno-hyoideus vein.
Sub.A.	Subclavian artery.
S.Ven.	Sinus venosus.
S.Ven.O.	Orifice of sinus venosus leading into the auricle.
Tr.F.L.V.	Transverse filament lymphatic vessels (nutrient veins?).
V.	Point where cephalic sinus joins jugular vein.
V.A.	Ventral artery.
V.Ao.	Ventral aorta.
V.Br.L.T.(1)–(4).	Ventral branchial lymphatic trunks (nutrient veins?) 1 to 4, *Lepisosteus*.
V.Br.L.T.(1)–(4)*O.*	Ventral branchial trunks opening into the inferior jugular.
Ven.	Ventricle.
V.L.T.	Ventral lymphatic trunk.
V.L.T.O.	Ventral lymphatic trunk opening into the pericardial sinus.
V.V.	Ventral vein.
V. Vas.	Vasa vasorum.
W.C.	White corpuscle or leucocyte.
x.	Combined trunk formed by the union of the third and fourth dorsal branchial trunks with the dorsal fork of the second branchial trunk.
z.	Point of union of the third branchia trunk with the fourth.
I.	Olfactory nerve.
II.	Optic nerve.
V.(2).	Truncus buccalis maxillo-mandibularis.
V and VII.	Trigemino-facial complex.
VIII.	Auditory nerve.
IX.	Glossopharyngeal nerve.
X.	Vagus nerve.

PROCEEDINGS

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. IX, PP. 159–178. JULY 31, 1907.

ORIGIN AND EVOLUTION OF ANGIOSPERMS THROUGH APOSPORY.

BY O. F. COOK.

THE phylogeny of the coniferous plants or gymnosperms has been traced through the ferns and the Cycadofilices, an extinct intermediate group. Evidence of this alliance of the gymnosperms has increased rapidly in recent years, but has not been accompanied by any equally convincing indications that the angiosperms or true seed-bearing plants shared the same pteridophytic ancestry. Morphologists may be willing, therefore, to consider an alternative possibility, that the origin of the angiosperms should be sought more directly in some such primitive condition as the thallose liverworts, without the need of following back through the stages of development represented by the ferns and other "vascular cryptogams."

This briefer course of evolution would be opened if we were to consider the female reproductive apparatus of the angiosperms as analogous to the fern-prothallia which are sometimes produced directly from the parent plant, without the intervention of spores, that is, by aposporous growth from cells of the parent fronds. In this method of development the aposporous prothallus serves as means of attachment for the young plant during its embryonic stages, and can supply it with food-materials drawn from the parent.

A reason why this rather obvious analogy has failed to receive adequate consideration in the past may be found in the fact that apospory is usually associated with apogamy or other absence of normal fertilization, and is commonly thought of as a method

of asexual propagation. It can be shown, however, that this implication is not necessary, and that apospory need not interfere with the formation of sex-cells, nor with the continuation of truly sexual methods of reproduction. The elimination of the spores does not require that the fusion of chromatin (mitapsis) which must precede the formation of new sex-cells, shall also be omitted; it may be merely deferred and passed along to later generations of cells. If instead of occurring in the body of the parent plant, mitapsis were carried over into an aposporous female prothallus and thus approximated in time to the formation of the sex-cells we would have a condition similar in all important respects to the reproductive system of the angiosperms.

The whole group of the archegoniate plants affords a conspicuous instance of such deferment of mitapsis into later and later cell-generations, instead of taking place in the fertilized egg-cell as in the lower algæ. Unless mitapsis had been deferred the larger "sporophytes" and increasingly abundant sporogenous tissues which characterize the various families of archegoniates could not have developed. A still further postponement of mitapsis, combined with apospory, is therefore entirely in accord with the general course of evolution already followed by the group from which the primitive angiosperms are now commonly believed to have arisen.

THE VEGETATIVE CAPSULE OF ANTHOCEROS.

Anthoceros is a thallose liverwort which has been accepted by some as representing a primitive ancestor of the ferns, but which may be used with greater propriety to illustrate a stage in the development of the angiosperms.

Until fruiting begins, a plant of *Anthoceros* consists merely of a thallus, or plate of slightly differentiated cells, lying flat on the surface of moist soil. The fruiting part of the plant is an upright, cylindrical, two-valved capsule. The outer walls of the capsule consist of fleshy, green tissues, like those of the thallus, and similarly endowed with the power of vegetative growth. This vegetative capsule is even provided with specialized breathing-pores, though the thallus is without stomata.

Finally, the growth of the capsule is persistent and indeterminate. New tissue continues to form at the base and to push up from below long after the terminal portion has ripened its spores and shriveled away.

A first step toward the derivation of angiosperms from *Anthoceros* would be taken if the two-valved vegetative capsule should acquire the power to pass through a resting stage and renew its growth, after the death of the parent thallus. Some of the species of *Anthoceros* are perennial, even in very dry regions, either by the survival of the tip of the thallus, or by specialized tubers. The capsule continues to grow as long as the thallus lives, and, as Campbell well says: "All that is needed to make the sporophyte entirely independent is a root connecting it with the earth." Most of the liverworts, both thallose and foliose, are able to survive long periods of drought, as are also the moss "fruits" and the fern-fronds which correspond to the capsule of *Anthoceros*.

ANTHOCEROS NOT REPRESENTATIVE OF ANCESTRAL PTERIDOPHYTE.

It has been customary to utilize *Anthoceros* as the best living analogy for an archetypal pteridophyte, but the sporangia or capsules of ferns are much more similar to those of some of the more primitive members of other orders of liverworts, such as the Marchantiaceæ and Ricciaceæ. It is only in the mosses and in the Anthocerotaceæ that the walls of the sporogonia or capsules have become thickened and adapted to vegetative functions. The fronds of ferns may be said to correspond to the thickened capsule-bases of the Marchantiaceæ and Jungermanniaceæ. The delicate stalked capsules themselves are still very much in evidence in the ferns and have not assumed any vegetative functions.[1]

[1] The diversity of liverwort capsules in these respects is shown by a recent paper by Lang.

"When we look for sporogonia resembling that of *Cyathodium* probably the closest comparison as regards the relation between capsule and foot is presented by *Sphærocarpus* and *Riella*. The mode of segmentation of the embryo in these genera has much in common with the Marchantiaceæ, the comparison between *Sphærocarpus* and *C. cavernarum* being particularly close. In both *Riella* and *Sphærocarpus* the mature sporogonium consists of a small capsule connected by

Likewise, it is only in the capsules of mosses and of *Anthoceros* that we find a columnella or central pith of sterile cells serving as a supporting axis. An internal framework is quite as important as chlorophyllose external walls, if a capsule is to be transformed into a vegetative structure. Ferns of the family Hymenophyllaceæ have their capsules clustered on the ends of percurrent veins and surrounded by cup-like expansions of the margins of the fronds, thus giving a striking superficial resemblance to the columellate capsules of mosses. But this apparent columella of the Hymenophyllaceæ bears many capsules, instead of being enclosed in a capsule, as in the mosses and in *Anthoceros*. Instead, therefore, of representing an ancestral condition from which the fern phylum might have developed, *Anthoceros* appears to be farther advanced than the ferns in the direction of the angiosperms.

The prothalli of ferns may be taken as the best indication of the nature of their bryophyte ancestors. Fern prothalli viewed as liverworts represent very primitive types. Their habit of bearing archegonia on the under side may explain why a fern sporangium, instead of developing merely a nursing-foot for more efficient connection with its parent prothallus, found means to get into communication with the ground. The development of the capsule base of vegetative cells was then no longer limited by the supplies of water and nutrient substances which the prothallus could provide, and the way was open for the evolution of a new plant structnre.

It is often assumed that the fern prothallus has degenerated, since the sporophyte has so greatly surpassed it in size and vegetative activity, but there is no very good reason for supposing that the prothallus is any smaller or less important now than before. The theory of the reduced prothallus has been applied to the ferns in order to reconcile us in advance to the assump-

a narrow stalk with a small bulbous foot. In some species of *Riella* the stalk consists of a single row of cells, as in *C. cavernarum*, and the bulbous foot, which in *Riella* is composed of more numerous cells, shows a tendency to form absorbent processes. In all the Merchantiaceæ and the Jungermanniaceæ, with these exceptions, the foot and seta of the mature capsule appear to be relatively bulky. On the other hand, in the Ricciaceæ the sporogonium shows no trace of a foot." See Lang, William H., 1905. On the Morphology of *Cyathodium*, Annals of Botany, Vol. 19, p. 424.

tion that a much more extensive reduction has taken place in the angiosperms. Apospory affords a suggestion of a method by which the independent vegetative prothallus of the ancestors of the angiosperms may have been directly eliminated instead of being gradually reduced to a non-functional status.

VEGETATIVE CAPSULES OF MOSSES AND FERNS.

When once a capsule like that of *Anthoceros* had taken on the vegetative functions of the thallus there would be nothing unreasonable in expecting that it might also be able to pass a resting stage in the dried condition, revive again on the recurrence of favorable weather, and send out fresh root-hairs to draw moisture from the soil, just as the young fern-plant does. The capsules of mosses sometimes give rise to delicate protonema-like filaments, as though attempting to produce roots and thus to maintain an existence independent of the parent leafy axis. This possibility is quite within their reach, as far as powers of assimilation are concerned, for the vegetative tissues of moss-capsules are highly differentiated and even provided with breathing-pores, which the leafy part of the plant does not have. In the moss genus *Buxbaumia* the leaves are reduced to mere rudiments deficient in chlorophyll, showing that the assimilatory and vegetative functions have been definitely transferred to the large, hollow-walled capsule.

The independent existence of the vegetative *Anthoceros* capsule would afford a plant like a seedling angiosperm with its two cotyledons, but bearing spores on the inner faces of the cotyledons. No steps are required which have not been closely paralleled in the evolution of one or another of the archegoniate plants.

ACROGENOUS VEGETATIVE PROPAGATION.

The further stages of progress toward angiospermy are equally supported by precedents in the vegetable world. An intercalary lengthening of the periods of vegetative growth and propagation marks the histories of many groups of higher plants. The simplest thallose liverworts, the Ricciaceæ, are annuals, but the Marchantiaceæ are perennial, one thallus growing out of the tip of another in indefinite succession. The primitive mosses

like *Archidium* are also annual and each plant is normally fertile, but among the higher mosses fruiting is often deferred till a considerable number of plants, often a whole tuft, has been formed by vegetative propagation. The same is true among the ferns, and in many different families of the flowering plants. It is accordingly not unreasonable to think of the cotyledons as multiplying, after vegetative growth has commenced, to form a poly-cotyledonary, leafy axis, with the spore-bearing functions restricted to the upper members of the series, just as many ferns produce spores only on a few small specialized fronds. The formation of a compound plant by adding units one above another is simpler and more direct than the budding out of lateral shoots from lower down, like those which form roots and root-stocks. The successive members of the series have the same relations to each other as the original basal unit might have had to its parent plant, or as the vegetative capsules of *Anthoceros* and of the mosses still have. The jointed internodal structure which characterizes the stems of angiosperms is itself a distinct intimation that the plant-body in this group has been made up in a manner essentially different from that of the comparatively jointless stems of higher pteridophytes and conifers. That the plumule may be viewed as an outgrowth from the cotyledons, instead of being a predetermined structure to which the cotyledons are accessory, is indicated by the fact that in some plants there is more than one plumule, and that in others, such as the cotton plant, buds many arise in the axils of the cotyledons, and in others still, small pieces of the cotyledons can produce plumules.[1]

It is also noteworthy that other internodes, like the cotyledons, grow by intercalation, or at the base, instead of at the apex, the terminal bud having been laid down in advance, like the plumule, before the expansion of the internode begins. This principle of intercalary growth is illustrated most strikingly, perhaps, in the palms, in which not only the internodes themselves, but their leaves and inflorescences are definitely constructed from

[1] Mr. A. J. Pieters informs me that in several species of *Plantago* pieces of the cotyledons have the power of producing new plumules and root-hairs from the cut surface, and that perfectly normal plants have grown to maturity from such new-formed plumules.

the apex downward. The terminal portions of the leaves and inflorescences may be pushed out as finished products while their basal tissues are still in a rudimentary and delicately protoplasmic condition.

The development of a series of capsules or cotyledon-individuals by apical budding or plumule-formation is certainly no more remarkable than that new moss-plants should arise from cells of the stem of a moss-capsule, or even from the lid. Nor is it an any more improbable phenomenon than the development of adventitious buds as a result of injuries to parts which normally do not produce buds at all, as for example, in a piece of cotyledon of *Plantago* or in the embryo of *Sechium*, which produces new roots and new plumules if the originals fail of their purpose.

APOSPORY WITH DEFERRED MITAPSIS.

The final step in the present suggestion of a course of evolution toward angiospermy is that the primitive cotyledon-like plant becomes aposporous, so that it can produce prothalli instead of spores, the fusion and reduction of the number of the chromosomes (mitapsis) being deferred until the egg-cells are to be formed. Apospory, with the retention of the double number of chromosomes has been ascertained to exist in ferns of the genus *Nephrodium*.

"The prothalli of the two apogamous varieties, *Nephrodium pseudo-mas* Rich. var. *polydactyla* Wills, and *Nephrodium pseudo-mas* Rich. var. *cristata apospora* Druery, exhibit two striking differences. Whereas in the former nearly all the prothalli, except very young ones, have a strand of vascular tissue extending throughout the greater part of their length, in the latter only two cases of feebly-developed trącheides have been seen. Again, in *Nephrodium pseudo-mas* var. *polydactyla*, migrating nuclei, some of which have been seen to fuse, are a characteristic feature. Out of a large number of prothalli it was found that about 73 per cent. of the young ones exhibit phases of nuclei passing from one cell to another. As this fern produces fertile spores, it is almost certain (it is hoped shortly to settle this point) that there is a true reduction during the division of the spore mother cells, the doubled number charac-

terizing the sporophyte is apparently brought about by the migration and fusion of prothallial nuclei.[1] In *Nephrodium pseudo-mas* var. *cristata apospora*, out of 80 prothalli examined, only two showed possible cases of nuclear migration, and these were open to doubt as regards their interpretations.

The reason for the absence of fusion in other cases is obvious, for the prothalli of *Nephrodium pseudo-mas* var. *cristata apospora*, as we have seen, already possess the full complement of somatic chromosomes. Hence there is no need for the fusion of two nuclei which, by their union, double the number of chromosomes."[2]

Two varieties of the same fern show two very different systems of apospory, thus illustrating the range of choice of aposporous methods of reproduction which lay open to the ancestor of the angiosperms. In the one variety (*cristata apospora*) apospory is accomplished without a reducing-division and the resulting prothallus develops a new plant without fertilization. In the other variety (*polydactyla*) the development of the aposporous prothallus is initiated by the chromatin-fusion of a vegetative cell. Two vegetative cells of the prothallus afterward unite, and thus restore the double number of chromosomes, so that the new plant can be developed.

A less violent departure from normal methods of reproduction would place a primitive plant on the road toward evolution into an angiosperm. The type of apospory which the angiosperms appear to represent is somewhat intermediate between these two, and somewhat less abnormal than either. Apospory, as illustrated in angiosperms as a group, does not involve that mitapsis be omitted altogether, as in one of the fern varieties: it is merely postponed to a later generation of cells. Neither is there an abandonment of fertilization by the male gamete as in the other fern variety. If the aposporous prothalli were to retain more of the functions of true prothalli, they would be able to produce

[1] While the article was in the hands of the printer this supposition has been confirmed. See Farmer, J. Bretland, and Digby, L., 1907. Studies in Apospory and Apogamy in Ferns, in Annals of Botany 21: 161–199, Pls. 16–20, Apr. 1907.

[2] Digby, L., 1905. On the Cytology of Apogamy and Apospory, Proc. Royal Soc. London, 76: 463.

young plants sexually, and these would then correspond completely, in their origin, with the embryo of a flowering plant. The parallel with one of the *Nephrodium* varieties is complete in the genus *Bryophyllum* where from certain points on the margins of the leaves young plants can arise, and not merely ovules which have to be fertilized, or pollen-grains to fertilize them. In the genus *Begonia* the tissues of the leaves retain still more of their cotyledonary functions and can produce aposporous new plants with almost as much facility as in *Nephrodium*.

The more complete form of apospory, shown in *Nephrodium*, *Bryophyllum* and *Begonia*, not only omits the spores, but also passes by the stage in which new conjugations can be undertaken. It becomes simply a method of vegetative propagation. As such it may have an environmental advantage, but it constitutes at the same time a grave evolutionary danger. Habitual vegetative propagation conduces to deterioration of sexual processes and final sterility. The more advantageous purely vegetative forms of aposporous propagation might become, the more certain would be the extinction of the species.

In proportion as plants rely upon vegetative propagation the power of sexual reproduction declines. Many domesticated and wild plants might be cited as representing stages in this process of deterioration. That there are no wild angiosperms in which the power of sexual reproduction is entirely lacking, may be taken to indicate that organisms of this stage of development can not long survive the discontinuance of sexual reproduction.

It would appear, then, that the form of apospory which could open the way to the evolution of angiosperms must have been radical enough to eliminate the macrospores and attach the aposporous prothallus to the parent plant, but not great enough to exclude the formation of egg-cells and the continuation of sexual reproduction.

ANTICIPATION INSTEAD OF RECAPITULATION.

The currently accepted doctrine or "biogenetic law" of recapitulation tends to conceal the possibility of such evolutionary

changes as apospory. Recapitulation affords an idea and method of expression often very convenient for describing in a general way the facts of developmental history, but evidently does not represent a universal or causal principle or a necessary sequence in evolutionary progress.

In the archegoniate plants there are numerous independent instances of what might be called syncopation or anticipation, rather than recapitulation, for instead of merely following over the ancestral lines of development in gradually shorter and less accentuated form, various pieces of the life-history appear to have dropped out, suddenly and completely. Thus in apospory a cell which might normally give rise to spores, produces, instead, a prothallus, such as might grow from the spores, which are then entirely omitted from the program. In a similar manner, the conjugation of two of the unspecialized cells of the prothallus may result in the growth of a sporophyte, the formation of specialized archegonia, antheridia and gametes being entirely omitted. Nor do these instances show the limits of anticipatory abbreviation of the life-histories of the archegoniate plants.

Instead of merely producing prothallia by apospory, many ferns produce young plants by direct growth from the cells of the leaves. Likewise in *Isoetes*, young plants may replace the sporangia, in the axils of the leaves, though it is possible that the thread or column of cells on which these aposporous plantlets are borne may represent the prothallus. Indeed, it may be that *Isoetes*, rather than the terrestrial heterosporous archegoniates, represents the nearest pteridophytic analogue of the flowering plants. Many of the smallest and least specialized angiosperms are aquatic types, like the Lemnaceæ and the Podostemonaceæ, and some of them have little more differentiation of tissues than *Anthoceros* itself.

Podostemon and its aquatic allies may never have had the acrogenous internodal structure of the higher angiosperms, and may illustrate a different method by which angiosperms could arise from an *Anthoceros*-like ancestor. The so-called leaves of the Podostemonaceæ appear much more analogous to the fronds of ferns and algæ than to the leaves of other angio-

sperms, and appear to be mere thalloid outgrowths of the primitive capsule-base, like the fronds of ferns, instead of developing as an acrogenous series of vegetative capsule-units.

Systems of botanical classification usually treat the Podostemonaceæ as degenerate representatives of one or another of the terrestrial families, but the justification for this is not obvious. That the family may prove to have historical significance as a primitive group of angiosperms is suggested by some Paleozoic fossils to which my attention has been called by Mr. David White. These remains have been looked upon hitherto as ferns, but Mr. White has ascertained that they produce quadrivalvate capsules each apparently containing a single seed-like body. The resemblance to some of the recent Podostemonaceæ is very striking throughout. Indeed, it is not now possible to specify any differences by which they can be excluded from that group, though Mr. White assures me that paleontologists will be very reluctant to admit the existence of even very primitive angiosperms in an epoch so remote.[1]

ELIMINATION OF MACROSPORES BY APOSPORY.

If the present view can be justified, it will not be necessary to think of the egg-cell or of the egg-apparatus as representing a macrospore which remains attached to the parent plant and germinates, instead of falling off as macrospores should. The attachment of the young plant to its parent is adequately explained by apospory, and can be viewed as entirely parallel with the attachment of a fern-capsule to its parent plant or of the very young fern-frond to the female prothallus from which it springs. The egg-apparatus can be looked upon as the arch-

[1] The only obvious difference yet detected between these Palæozoic fossils and the modern Podostemonaceæ lies in the fact that the capsules of the latter are many-seeded, while the supposed seeds of the fossils are single, and much larger. Such diversities in the numbers and sizes of seeds inside the same family are very frequent, of course, among the flowering plants. The habits of life of the Podostemonaceæ would render many small seeds preferable to fewer large ones, so that a reduction in size and an increase in numbers might naturally be expected as a result of a long evolutionary opportunity such as any extant descendants of these paleozoic plants would have had. They are aquatic plants, living in tropical water-courses, but the rocks over which they creep are often completely exposed for long periods in the dry season. The seeds have the primitive function of carrying the species through the annual period of drought.

egonium of an aposporous prothallus, the only essential difference being that mitapsis has been postponed until shortly before the formation of the egg-cells.

The divisions of the pollen nucleus may be homologous with the subdivision of a microspore to form a prothallus, but the fact that some of these nuclei may enter into conjugation renders them also homologous with the antherozoids to which the moss-plant or the fern-prothallus eventually gives rise. In a similar way, the egg-cell and its immediate predecessors may be compared directly to those of the archegoniates, but they need not be supposed to have the double homologies enjoyed by the pollen nuclei. The complete female homologue of the pollen-grain or microspore would, in this system, no longer exist, the female prothallus being supplied by aposporous development before mitapsis takes place. The aposporous prothallus anticipates and supplies the period of life-history previously attained by the independent development of the detached macrospore.

A prothallus which arose by apospory, by maintaining an intimate contact with the parent plant, would be able to nourish and protect its progeny much better than the prothallus developed from a detached macrospore. The relation of the young plant to its prothallial parent would be quite the same as that of a moss-plant to its capsule or a fern plant to its prothallus, as already stated. The difference lies in the special relation of the aposporous prothallus to its vegetative parent.

ASSOCIATION OF TWO GENERATIONS BY APOSPORY.

Under the doctrine of alternation of generations it is often said that the moss-capsule develops as a parasite on the parent plant. In the angiosperms there would be, by parity of reasoning, a double parasitism, the embryo is a parasite on the nucellus, and the nucellus upon the parent plant. Parasitism is, however, hardly the correct word, for the moss-capsule, the fern-frond and the angiosperm-embryo are all developments from fertilized egg-cells. The difference is merely that of the stage at which the gametes or their products shall part company with their parent organisms. By continuing to assist the fertilized egg-cell, and allowing it to develop into a capsule, the moss-plant is able to pro-

duce thousands of spores from a single archegonium, instead of four only, or merely a few. The plants have simply followed the same course as the animals, in extending the periods of family relations. The capsule is the offspring of the moss plant, the prothallus the parent of the fern. The angiosperms add another member to the series of prolonged family contacts. The young embryo might be said to be nourished not only by a mother, but also by a grand-mother. The archegoniate plants usually bring only the members or phases of one generation or life-cycle into definite supporting relations, but the aposporous ferns and the flowering plants are able to connect in this way two entirely distinct generations. Unless apospory takes place, mitapsis concludes each generation with the formation and scattering of separate spores, from which the next generation must be independently built up. But by means of apospory and delayed mitapsis two previously separated generations can be brought into effective contact. It would seem, then, that it is apospory through which the evolution of the angiosperms has become so nearly parallel to that of the mammals that both have actually been described as placentate organisms.

ORDER OF CHANGES NOT ESSENTIAL.

It is not necessary to hold that the changes involved in such an evolution of angiosperms from aposporous archegoniates took place in the particular order in which they have been mentioned. There is no objection to supposing that any or all of them might have been in progress during the same period, while the plants were still too small and the tissues still too soft to favor the preservation of fossil remains. The extension of the primary capsule-base or nursing foot into a leafy axis by vegetative growth may have come about after the aposporous seed-producing condition had been reached, rather than before. In *Streptocarpus* we have plants in which the cotyledons are the only vegetative organs, the plumule consisting only of flower-buds and in *Welwitschia* (*Tumboa*) there are at most but four true leaves.

If the habit of apospory were adopted far enough back it would have greatly facilitated the other changes, if it did not

actually bring them about. By enabling the plant to elide that part of its life-history in which the delicate spore and prothallus must find continuous moisture, it would deliver the primitive angiosperms from the disabilities suffered by most of the ferns and enable them to advance into the open sunlight.

Young angiosperm seedlings are already of very large size in comparison with fern spores, and are to that extent the better able to establish themselves rapidly in exposed situations, and send their roots down promptly into the permanently moist subsoil, instead of remaining dependent upon the precarious surface conditions which still restrict most of the pteridophytes to humid, sheltered places.

The origin of angiosperms through apospory requires, as already intimated, a less violent deviation from the normal and primitive methods of sexual reproduction than that which is definitely known to exist in *Pellæa*, *Bryophyllum* and *Begonia*, so that no objection can be made to it on the ground of feasibility.

INTERNODAL METAMERISM OF ANGIOSPERMS.

There are several morphological advantages in recognizing this more simple and direct route of evolution. The first and most general is that it would explain the internodal structure of angiosperms, by establishing on a natural basis the complete homology of all the vegetative parts and floral envelopes, the cotyledons, leaves, sepals, petals, carpels and stamens. All alike correspond to the same primitive structures, the capsule-valves of the *Anthoceros*-like ancestor.

The internodes of the angiosperms have an individuality of the same kind as that of the fronds of ferns. The cotyledons may be considered as members of the series of internodes or joints of which each compound plant individual is composed. The cotyledons are usually less different from the succeeding vegetative internodes than these are from the internodes of the flowers and fruits, to which the vegetative internodes finally give rise. In some plants, such as *Persea* and *Pachira*, the internodes which immediately succeed the cotyledons are specialized. In others, like *Eucalyptus*, young plants may continue for a long time to produce leaves which are very different from those

of the adults. That there is no essential distinction between the vegetative and the floral internodes, has long been recognized. The flower leaves may take on at times the green color and firmer texture of the vegetative organs, as often happens in roses and trilliums, or the carpels themselves may function as green expanded leaves after opening to scatter their seeds, as in *Sterculia*, or they may take on functions of the cotyledons or of the endosperm by storing nourishment for the use of the young plant of the next generation, as in the long-persistent pericarps of *Sechium* and *Melocanna*.

The individual angiosperm, like the individual worm or centiped, is a doubly composite organism. It is not merely a colony or complex of cells, but also a combination of a number of theoretically equal and equivalent body-parts or metamers, such as the internodes of the plants and the segments of the animals. The cells are associated into metamers, and the metamers are combined into the complete organism, just as the individual ants or bees join to make the still higher social unit or colony.

In the internodal metamerism of the angiosperms only one metamer is formed in the egg or embryo and the others are added by subsequent vegetative propagation. In the segmental metamerism of arthropods the association is more complete, in that numerous metamers are formed in the egg and usually few are added afterward, or none at all. Thus among the millipeds and centipeds where metamerism is very highly developed the larvæ of some groups are hatched with only three leg-bearing segments and the others supplied by intercalation at subsequent periods of moulting. But in other families, including those which have the largest number of joints, the young leave the egg with the full complement of segments. In the suborder Geophiloidea the number of segments ranges between 31 and 173, far exceeding the number of internodal joints of many plants.

In many of these lower types of animals a relative equality of the body metamers has been preserved, but in the higher groups the metamers become specialized and unequal. Similar inequalities exist in plants, even among vegetative metamers. Thus in numerous plants such as coffee, cacao, cotton and the Cen-

tral American rubber tree (*Castilla*) there are two kinds of branches. The metamers composing one type of branches are in all respects the equivalents of those of the primary stem or trunk, while the others are distinctly inferior and unable to produce or regenerate primary branches.

STRUCTURE OF VEGETATIVE METAMERS.

The ideal of a vegetative metamer of an angiospermous plant individual includes three kinds of parts: (1) the internode proper, forming a section of the stem of the plant, (2) an expanded assimilatory plate or leaf, usually adapted for exposure to light, and (3) a terete absorptive organ, or root, which usually buries itself in the ground and there produces root-hairs.

Internodes are generally simple, but the coffee shrub might be said to have compound internodes, since each primary internode produces two branches from extra-axillary buds. The number of leaves borne by each internode is usually only one or two, but some plants have whorls of several leaves, though this condition may be reached by the shortening of some of the joints. In most plants only the lower internodes produce roots, but there are also many species, as among the aroids and figs, where all the internodes bear roots freely, and in a very large number of plants they have the power of doing so under special conditions.

The more primitive types of leaves consist of two parts, a cylindrical basal sheath surrounding the next internode, and an expanded terminal blade. From the basal sheath stipules have been derived like those of Rosaceæ and Ranunculaceæ, and bud-scales like those of *Ficus* and *Castilla*. In *Inodes*, *Thrinax* and other fan-palms the sheath has been prolonged into a petiole, which ends in a ligule. On the other hand, *Desmoncus* and related genera of cocoid palms have ligules in the same position as the grasses, as direct extensions of the sheath, above the insertion of the blade. Evidence is thus afforded that in the Cocaceæ, at least, the petiole is not a part of the sheath, but a prolonged naked base of the midrib of the blade. Similar differences in the homologies of the petioles are doubtless to be found in the leaves of other angiosperms.

The leaf may be considered the most primitive element, and is in most cases also the most essential part of the plant metamer. The joints are often reduced to mere rudiments, and the roots entirely lacking. Sometimes internodes of special stems (root-stocks) are devoted to the production of roots. Sometimes roots produce buds and give rise to new stems or new plant individuals. Thus the many seedless varieties of the breadfruit are propagated from pieces of roots. In *Scchium* the primary metamer has no internode-like basal joint (hypocotyl), but many roots grow out independently from the united bases of the cotyledons. Root-hairs grow out in a similar manner from basal cells of the embryos of Podostemonaceæ. The cotyledons of *Plantago* and the leaves of *Begonia* and *Bryophyllum* also produce roots.

In addition to their absorptive functions, roots often serve as organs of aëration. Even subterranean roots may send branches upward into the open air for this purpose. This occurs not only in the mangroves and other swamp plants, but in cotton and other dry land types. Roots may also be specialized as haustoria in parasites, and as hold-fasts in climbers, or even as spines to afford a protective armature, notably in certain species of yams[1] and in the palm genus *Acanthorhiza*. Although the spines of *Acanthorhiza* are often large and compound like those of *Gleditschia*, it is apparent that they are roots, not only because there is a complete series of transitions, but also because of the large deciduous root-caps.

It is not impossible that even the spines of cacti may prove to be modified roots, instead of leaves. The spines of many species are capped, and their number, position and arrangement are at least as favorable to their being roots as to the usually accepted theory that they represent leaves. The modification that roots would require to become spines is much less than in the case of leaves. Not only in the genus *Peireskia*, but in many species of *Opuntia*, true leaves are developed, and it is in the axils of the leaves that the spines arise, just below the point from which

[1] Safford, W. E., 1905. The Useful Plants of the Island of Guam. Contrib. U. S. National Herbarium, 9: 69. These spine roots of *Dioscorea* protect the edible starch-filled tubers.

the new growth appears, whether of flowers or branches or of true functional roots. A cluster of spine-like leaves or branches in this position would need to represent a rudimentary branch or series of branches. The arrangement of these would be spiral or concentric, which is evidently not true of the spines.[1]

APOSPORY AND ALTERNATION OF GENERATIONS.

In comparison with the current application to the higher plants of the doctrine of alternation of generations, the present suggestion may also claim merits of simplicity and directness. It is no longer necessary to imagine that two generations originally alike have become specialized, nor that one generation is borne parasitically on the other except in the manner in which the aposporous fern prothallus is borne.

The evolutionary history of the angiosperms can be thought of as a definite progressive sequence, without the need of supposing that one "generation" has deteriorated while another has expanded. The macrospores and the vegetative prothalli, having been completely eliminated from the life-history of the primitive angiosperms, did not have to be gradually reduced from a functional to a rudimentary condition.

The so-called endosperm of the true seed plants need not be supposed any longer to correspond to the prothallial endosperm

[1] Professor Edward L. Greene has pointed out to me that the spine-clusters of *Mammillaria* are similar and perhaps analogous with those of certain of the species of *Mesembryanthemum*, which represent marginal spines of the reduced blade of the leaf, while the conical prominence upon which the cluster or compound spine is seated may represent the petiole or base of the leaf. The flowers and fruits of *Mammillaria* do not emerge, as in *Opuntia*, from the same point as the spines, but from the axils of the fleshy prominences which bear the spines. But Professor Greene considers the assignment of *Mammillaria* to the same family with *Opuntia* an artificial arrangement, so that an analogy between *Mammillaria* and *Mesembryanthemum* would not necessarily interfere with the recognition of the capped *Opuntia* spines as roots. That the spines of *Opuntia* and *Cereus* are not to be interpreted as equivalents of marginal projections of a reduced leaf-blade, seems to be proven by a fact observed by Dr. J. N. Rose, that in these genera new spines may be added one after another, even in very old clusters. Nor is it likely that new leaves would be pushed out in this manner, which is much more appropriate for branches or for roots. That the thorns of some of the cacti secrete nectar, as shown by Ganong, does not exclude the possibility that they are roots. Exposed root-tips often produce secretions, and my son Robert informs me that the secretion of the aërial roots of the corn plant has a sweet taste.

of the cycads and coniferæ. It is not built up before fertilization takes place, but afterward. It does not arise from a germinating spore, but as a result of the conjugation of two nuclei, comparable, perhaps, to the conjugations of adjoining cells which occur in the prothallia of certain ferns and give rise to the new double-celled structural phase by apogamy without the production of antheridia and archegonia, as though the ancestral form had all the liberty of alternatives possessed by the ferns and had ended by combining them into the complex and hitherto altogether mysterious reproductive processes of angiosperms. The part of the angiosperm which, in the present view, might correspond to the prothallus itself, is the nucellus. And even this relation would not be direct, for the nucellus of the angiosperms might not be homologous with the nucellus of the conifers and cycads, which, if current interpretations are correct, is more analogous to the placenta of the mammal than to an aposporous prothallus.

The obviously very great and fundamental difference between the angiosperms and gymnosperms would be adequately accounted for. The homologies which have been alleged hitherto appear very artificial, and leave us with a problem as difficult as that which they are intended to solve, namely, how structures derived from those of ferns or of gymnosperms could have become so completely different in the angiosperms.

VEGETATIVE PARTS REPRESENT STERILIZED REPRODUCTIVE TISSUES.

The deduction based by Bower on his studies of fern-structures would remain thoroughly applicable to the angiosperms, since their vegetative parts would still represent sterilized reproductive tissues. Indeed, this proposition becomes a mere truism after the essentially sexual nature of the double-celled structures of the higher plants has been realized. The growth of the whole plant body has been intercalated into the sexual process. It is built up during conjugation and not after conjugation has been completed.[1]

[1] Cook, O. F., and Swingle, W. T., 1905. Evolution of Cellular Structures, Bul. 81, Bureau of Plant Industry, U. S. Department of Agriculture.

FUNCTIONS OF THE APOSPOROUS PROTHALLUS.

The gymnosperms may be supposed to have the ovules and seeds naked because they are still borne in an endosperm which corresponds to the primitive, vegetatively functional prothallus, though it now remains attached to the much more highly developed double-celled structure which corresponds, in turn, to the capsule of the liverwort and the moss, the frond of the fern and the leafy axis of the club-moss. The ovule and seed of the angiosperm are borne, not on the original vegetative prothallus, but on a structure which, if it arose by apospory, would never have had independent vegetative functions. It need never have been very large, and could have been reduced very readily in becoming more specialized. There was no occasion to assume protective or nutritive duties, since there was always an enclosing capsule or carpel.

The fern and the flowering plant are alike in that their ancestors can be traced back to the capsules of simple thallose plants like *Anthoceros*, but there appears to have been, at some very remote point, a divergence of procedure, the group which gave rise to the ferns and gymnosperms retaining for a much longer period a functional prothallus which the adoption of apospory enabled the ancestors of the angiosperms to completely eliminate.

Lastly, a certain presumption of probability may be claimed for a suggestion which enables the peculiarities of such plants as *Nephrolepis*, *Begonia* and *Bryophyllum* to be associated with other phenomena of apospory and thus to find places in normal evolutionary history, instead of remaining mere meaningless "freaks of nature," because they may have appeared to lie far outside the pale of former interpretations.

PROCEEDINGS

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. IX, PP. 179–187. JULY 31, 1907.

HEREDITY AND MENDEL'S LAW.[1]

BY CHARLES B. DAVENPORT.

FROM its first appearance on earth the living substance has moved like the growing roots of a tree from a single point, without break in its continuity, but ever branching out in new directions. This fundamental stream is the germ-plasm. At intervals, as roots may send up shoots, so the germ-plasm produces the individual body or soma, whose primary purpose is to nourish the germ-plasm and thus assist its further progress.

The soma is important to the student of heredity because it is the index of the composition of the particular germ-plasm from which it arose. The study of somas shows that those arising from the same part of the germ-plasm are very similar; those from distant parts of the germ-plasm are very different; those nearer the starting point of any root are simpler in structure, while those arising more recently are more complex. These differences of the soma prove that the germ-plasm changes in structure and tends to become more complex. These changes in the germ-plasm constitute evolution, and the study of the laws of change of this germ-plasm and the artificial control of such change constitute at the same time the largest and most fascinating work of the modern biologist.

Inside the germ-plasm complex movements are going on. In the first place, the development of a soma at any point is usually

[1] An address delivered under the auspices of the Washington Academy of Sciences, Tuesday evening, February 26, 1907, in the Hubbard Memorial Hall, Washington, D. C.

preceded by the union of bits of the germ-plasm coming from different parts of the same motor stream, or even from two different streams, recently separated. This is union of sex cells, or gametes, in sexual reproduction. As every part of the germ-plasm is undergoing change, such unions bring together more or less dissimilar germ-plasms. Of the effect of such unions, we get some notion by studying the somas, or offspring that result. If the uniting germ-plasms are quite dissimilar the behavior of the union, as revealed in the soma of the hybrid offspring, is correspondingly interesting and significant.

A second sort of movement in the germ-plasm is molecular. Under certain, still unknown, conditions the composition of the germ-plasm changes and such changes reveal themselves to us as sports or mutations. These occur so irregularly and uncommonly that their study is difficult; but it is one of the aims of experimental work in evolution to initate and control such changes.

This evening I propose to speak only of the first kind of changes in the germ-plasm — namely, those due to combinations of two dissimilar sorts — and the effect of such combinations on the stream of germ-plasm that issues from the union. The laws of such combinations and their transmission constitute the science of heredity.

In analyzing the phenomena of heredity we must first conceive that the germ-plasm is composed of many units, such as Darwin named pangenes and Weismann determinants. Our knowledge of such units is confined to their representations in the soma — the *unit-characters* of organisms.

In studying heredity, we focus attention on the behavior of the unit-characters of the soma as the index of the changes in the germ-plasm. Practically, one breeds together two individuals having contrasted characters and observes the corresponding characters in the next somatic generation.

The results of such experiments are in the highest degree interesting and important. They are not yet predictable; indeed, they do not all follow a single law, but in the midst of the diversity of the results a unity is dimly visible. I propose now to cite typical examples of such inheritance in contrasted characters, illustrating the different modes of inheritance.

First, let us look at a case of color inheritance. If a bird having black feathers, like a Minorca, or one having black feathers mottled with white, like a Houdan, be crossed with a white bird, like the White Leghorn, the male hybrids are pure, or almost pure, white. White dominates more or less completely over black; but the black is not lost, it is merely overshadowed, for if two of these white hybrids be mated, about 25 per cent. of their offspring will be as black as the original parents. Such black grandchildren derived from two white parents are known as extracted blacks. The black color has been released from the dominance of the white; and if the extracted blacks be bred together they behave like a pure black race. A characteristic like black which recedes from view in the first hybrid generation, which may be extracted from the dominant type in 25 per cent. of the second generation, and which, after extraction, breeds true, is called a *recessive* characteristic.

The discovery of the law of inheritance in the case of dominant and recessive characteristics was made forty two years ago by an Austrian monk, Gregor Mendel, while experimenting with plants in his cloister garden. Mendel not only discovered his law, but gave a satisfactory cytological explanation of it. He states that the germ cells of the hybrid must divide into two kinds, each pure in respect to two opposed characteristics, the dominant and the recessive. When two of these hybrids are mated there are four equally probable events: an egg containing the dominant character *D* may be fertilized with a *D* sperm or an *R* sperm, and an *R* egg may be fertilized by a *D* sperm or an *R* sperm. Whenever the character *D* enters into the combination, that character dominates in the offspring; but where it does not enter, *R* shows itself in the same. The former event occurs in three-fourths of all cases; the latter in one-fourth, consequently only one-fourth of the offspring are *recessive*. This is in brief outline the essence of the Mendelian doctrine. It rests on the foundation of purity of the germ-cells and hence purity of the one-fourth of the second hybrid generation that is produced by the union *DD* and the one-fourth resulting from the union *RR*. These portions, inbred, should

yield only the dominant type and the recessive type respec tively. These expectations have been now so often realized that Mendel's law has gained deserved fame as the most important law of inheritance yet enunciated.

Many illustrations of this law are given by poultry. Thus when frizzled fowl are crossed with non-frizzled, the offspring are frizzled; from such frizzled hybrids 25 per cent. plain-feathered are derived. These plain-feathered birds have not, in 50 offspring, thrown one frizzled fowl.

When the silky fowl is crossed with plain-feathered fowl, all of the offspring have plain feathers. When the hybrids are mated 25 per cent. silky offspring result. Such silky offspring breed true. And so I might continue with a dozen illustrations drawn from my experience demonstrating the truth of Mendel's law.

As the truth of a new law becomes apparent, enthusiasm for it is apt to carry one to extremes — to declare its universality and to overlook exceptions. It is well to cultivate the skeptical frame of mind and to remember that what looks like the whole truth may be only partial and that an examination of the exceptions may lead to larger generalities.

First of all we find that even in cases of Mendelian inheritance in the second hybrid generation, the recessives that are supposed to come from two pure recessive gametes show in their somas traces of the dominant type. Thus when a crested bird is crossed with a plain-headed one, and the crested hybrids are then crossed *inter se* the extracted recessives of the second hybrid generation are plain-headed to be sure, but they show a disturbance of certain feathers. Again foot-feathering, or booting, is dominant, but in the cross between the Dark Brahma and Minorca small feathers can frequently be found on the feet of all the second hybrid generation where 25 per cent. bootless is expected. The boot character is not absent from the 25 per cent., but it is immensely reduced in expression as compared with the booted ancestor.

Second, we find that the two opposed unit characters are not always respectively dominant and recessive. Various classes can be recognized. In some cases both characters appear in the

first generation side by side — neither dominating. Thus, when the white Cochin is crossed by the red-black Tosa, the first hybrids are barred with white; in the next generation, to be sure, some white birds are produced, but these frequently show some yellow or buff; also red and black birds, but these have often a washed-out color. In this case there is no dominance and the germ-cells are incompletely pure. This combination is very common.

Another case is that sometimes seen when a black and white are crossed. Instead of white dominating (as is usually the case) the two colors seem to have equal potency and a fine mosaic occurs — the *blue*. This is almost a blend. When such blues are mated together one gets some blues, but also some black and white mottled in all proportions. Not only is potency of the two characteristics equal in the first generation, but the characteristics appear in all of the germ-cells and reappear in the second hybrid generation in the most varied combinations.

Again, a peculiar case of inheritance was revealed by some experiments made by Darwin. He crossed a White-faced Black Spanish with a pure white silky, which (except in plumage) is a melanic sport. The chicks were blacker than any Spanish chicks, or any other that I know. They continued black until as they grew to maturity the males gained red-laced hackles, saddles, and back-feathers and a broad red wing bar, like the jungle cock. For Darwin, this was a case of *reversion*, due to hybridization. But that it was not the consequence of hybridization *per se*, but of this specific cross, is evident from the fact that you do not get a similar hybrid except by crossing a black bird either with a silky, or a pure buff — both of which are devoid of black pigment. Moreover, the result differs according to the black races crossed. If a black Minorca is used, which represents the immediate ancestor of the Spanish, the red in the progeny is much reduced. If a black Game is used, which represents a comparatively recent blackening of a red and black bird, the progeny have much more red.

Still another case. Some fowl have five toes instead of the normal four. When a four- and a five-toed fowl are crossed

the offspring show no blend, they are either four-toed or five-toed, and neither character dominates. If the extra toe is well developed in the parents a large percentage of the offspring have an extra toe; if the extra toe is poorly developed in the parents a small percentage of the offspring have an extra toe. In this case we have a unit character — extra toe — but no dominance or recessiveness and no evidence of pure germ-cells. The result seems to depend on the relative potency of the four-toed and the five-toed tendency.

Third, we find that one of the two opposed unit characters may be dominant in certain individuals and their offspring — forming a dominant strain — the same character may be recessive in other individuals or strains. Thus when high nostril and low are crossed, the offspring have a low nostril, but in one case out of a hundred an individual gamete carrying high nostril prevailed over the gamete carrying low nostril and the offspring had a high nostril. Again I bred a single comb to a rose comb (rose being dominant) and, in the second hybrid generation, obtained some extracted single-combed birds. These inbred gave a hundred single combs and one rose comb; the ordinarily impotent rose comb determinant of the extracted singles here overpowered its mate.

But the most striking illustration of the potency of a strain appeared last summer. Two years ago I mated a tailless Game cock, No. 117, to some tailed white Leghorns and got 100 per cent. tailed birds. No. 117 is a bird imported from England; it was exhibited at the Louisiana Purchase Exposition, St. Louis, 1904, and took a prize. Last summer I mated together these tailed hybrids, expecting to get 25 per cent. tailless birds; of about 100 offspring none was tailless. I also crossed some of the tailed hybrids with their father — No. 117 — expecting to get 50 per cent. tailless. Of 88 offspring none was tailless. Altogether, out of 200 offspring of this tailless cock, where I expected 90 per cent. tailless birds, I got not one. On the other hand, using some of the same hens with another cock (the son of No. 117), from 50 offspring, where I expected 25 tailless, I got 24 tailless. In No. 117, although tailless, the tailed tendency strongly dominates over taillessness, so that not in the first nor

in the second hybrid generation does taillessness appear, and of the Mendelian segregation in the second hybrid generation there is no trace! On the other hand, another cock reveals typical Mendelian phenomena.

Finally, I will speak of a case which is perhaps most instructive of all. I crossed together a double-comb and a single-comb, and a Polish with a V-comb. The hybrids have a new type of comb called Y-comb; single in front like the stem of a Y and cleft behind like the Polish. Now in the first generation the proportion of the single and the double element varies. At one extreme the single element constitutes 5 per cent.; at the other extreme 95 per cent. Next, I bred together in various generations some of these hybrids with Y-comb birds and, summarizing the results, I found, out of several hundred progeny, about 25 per cent. single comb, 25 per cent. V-comb and 50 per cent. Y-comb. But when I came to examine the families in detail it appeared that whenever both parents had a large proportion of the single in their Y-comb, the proportion of a single-combed offspring rose from 25 per cent. to 40 per cent., or even 50 per cent.; and when the parents had a small proportion of single in their Y-comb, the proportion of single-combed offspring fell from 25 per cent. to 20 per cent. The 25 per cent. of single-comb that one gets on the average seems to prove the Mendelian doctrine of pure germ cells; but the fact that when the tendency to comb in parent is strong, 40 per cent. of the offspring have single-comb; when weak only 20 per cent., throws doubt on the Mendelian doctrine of purity, and hints at a law of relative potency.

In the foregoing I have described the typical Mendelian phenomenon and also various cases of deviation from it — cases of contamination of the so-called pure type extracted from hybrids — cases of lack of dominance, but of particulate or blending inheritance; and cases of potency of one unit character over its antagonist — a potency not constant but varying with the individual or with the strain. Taking all cases into account it is clear that Mendel's law does not cover all; and, if not, it must be a special case of a more inclusive law.

Can we find a more general expression for the inheritance of

characteristics which will cover all these cases? I think we can and that it may be called the law of potency. At the one extreme of the series we have equipotent unit characters, so that when they are crossed the offspring show a blend, or a mosaic between them. This is nearly the case with the length of ear in rabbits, as Castle has found; it is probably also true for length of beak in poultry. At the other extreme is allelopotency. One of the two characteristics is completely recessive to the other. This allelopotency is sometimes uniform, as in the case of taillessness in No. 117, heretofore referred to; or in some strawberry hybrids. Usually, it is alternating like taillessness in the son of No. 117. Typical Mendelism comes under the head of alternating allelopotency and it is to Morgan that we owe the first, clear appreciation of the fact. According to his theory, purity of the germ cells does not exist; but a dominant characteristic involves a recessive, as, in electricity, a positive charge involves a negative one. Similarly a recessive characteristic always carries hidden a dominant one. In the first hybrid generation the dominant character is alone evident, but in that generation two kinds of germ cells are produced with opposite characteristics latent. Thus the dominant germ cells have the recessive character latent; the recessive germ cells have the dominant character latent. And segregation is rather functional than structural.

Between the two extremes of equipotency and allelopotency lies the great mass of heritable characteristics which, when opposed in heredity, exhibit varying degrees of potency. This sort of inheritance may be called heteropotency. Heteropotency is exhibited in the case of the elements that make up the Y-comb and in extra toes. It is the usual form of inheritance — that which the breeder relies on when he selects the best appearing animal or plant; or that which throws the largest percentage of favorable offspring.

The law of potency seems thus as a general expression for all the forms and exceptional cases met with in heredity. But it does little to help us toward an understanding of the physical basis of heredity, or towards its control. The next step is to determine the conditions of the different sorts of potency. We

know in a general way that progressive characteristics dominate over the more embryonic; but we have to learn the meaning of individual potency and the reason why some pairs of characteristics exhibit equipotency or heteropotency and others allelopotency. As ever in science the formulation of a law only awakens a new series of inquiries.

DISCUSSION.

By W. J. Spillman.

In listening to the address of Doctor Davenport, this evening, it has occurred to me that I might be able to suggest a possible explanation of one of the characteristics noted in the offspring of the hooded fowl. Professor Bateson made many experiments with walnut-combed fowls, interbreeding them with a single-comb, finding the walnut-comb to be compounded of the pea-comb and the rose-comb.

It is possible that the "hood" is composed of two characters intead of being a single element in itself.

Suppose the hood character to depend upon two factors *T* and *t*, and that *T* is much more important than *t* in producing the character. The allelomorphic formula of the pure hooded fowl would then be *TT*, *tt*; gametes *Tt*.

The formula of fowls with plain heads is *OO*, *oo*; gametes *Oo*. The cross is *TO*, *to*; gametes *Tt*, *TO*, *Ot*, *Oo*.

Fortuitous union of these gametes gives

1 *TT*, *tt*.	2 *TO*, *tt*.	1 *OO*, *tt*
2 *TT*, *to*,	4 *TO*, *to*.	2 *OO*, *to*
1 *TT*, *oo*,	2 *TO*, *oo*,	1 *OO*, *oo*.

Thus *T* and *t* are both present in 9-16ths of generation F_2.

T alone in 3- " " " "
t " " 3- " " " "
and both are absent in 1- " " " "

If *T* alone is difficult to distinguish from *T* and *t* together, this would give twelve hoods and four smooth or nearly smooth heads, or three hoods to one smooth head, which agrees with Dr. Davenport's results. But of the smooth heads three-quarters would show the slight tendency to the hooded condition, due to the presence of character *t*, provided, of course, my suggestion is correct. This explanation is merely an hypothesis and may or may not be correct.

PROCEEDINGS

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. IX, PP. 189–240. JULY 31, 1907.

MENDELISM AND OTHER METHODS OF DESCENT.[1]

BY O. F. COOK.

SYNOPSIS

Introduction 189
The nature of experiments in descent 191
Parent organisms produce parent gametes 192
Parent gametes produce conjugate organisms 192
Conjugate and exjugate reproduction 193
Conjugates produce perjugates 195
Summary of the five elements of descent 197
Mendelism as a method of descent 198
Primary methods of descent 198
Synopsis of methods of descent 199
Diagram of methods of descent 216
Position of Mendelism as a method of descent 218
Mendelian "principles" not demonstrated 218
Mendelian inheritance of mutations 220
Problems of expression and transmission 224
Relation of Mendelism to normal diversity of descent 230
Evolutionary implications of Mendelism 232
Conclusions 238

ALL students of Mendelism must be thankful to Professor Davenport for the extensive and very interesting summary of the facts which his experiments have brought to light, and we are very fortunate in this opportunity of having them illustrated

[1] An outline of this paper was presented in a discussion of Professor Davenport's lecture on "Heredity and Mendel's Law," before a meeting of the Washington Academy of Sciences, on February 26, 1907. Considerable amplification has been found desirable in order to carry out more fully the plan of a definite comparison of Mendelism with other methods of descent.

and presented at first hand. The only regret is that the lecture was not continued to the point of explaining how these facts are to be interpreted and brought into relation with the more general subjects of heredity and evolution. Details of scientific experiments are interesting to specialists in the same field, but we do not expect the general public, or even our colleagues in other departments of science, to pause and give special heed to what we have found unless we have reason to believe that our facts have some particular and unusual significance. It is not improper to ask, therefore, what are the new facts of general import which have been revealed by experiments in Mendelism?

Phenomena of this kind have received a large amount of special study in recent years, because it has been claimed that they prove new principles of heredity and open new routes to the solution of the larger problems of organic development. Such claims of great and special significance for Mendelism are due largely to the fact that these experiments brought for the first time a fairly definite mathematical factor into the problem of descent. In Mendelian crosses or hybrids there is a definite and uniform proportion between the expression of characters in what are called the first and second generations. It has not unnaturally been supposed that this regularity of proportion must obey an internal law or principle of descent governing the relations and combinations of characters. Definite mathematical relations must represent, it has been argued, definite entities inside the germ-cells. Here, at last, appeared to be a triumphant justification for the mechanical speculations of Darwin, Nägeli, and Weismann, to the effect that characters are transmitted from generation to generation by means of minute determinant particles or character-units of the germ-cells. It was found possible to explain the mathematical relations of typical cases of Mendelism by supposing that the presence or absence of certain particles in the germ-cells determined the presence or absence of the character in the adult organism.

In a Mendelian cross the parents differ in at least one pair of definitely contrasted characters. All the individuals of the so-called first generation show the character of one of the parents, which is called the dominant. In the following generations

three quarters of the individuals have this character of the dominant parent, and one quarter the other character (recessive), which did not appear at all in the first generation. It is this definite difference of proportions in the two generations which Professor Davenport has accepted as the basis of the Mendelian principles of heredity, and as a demonstration of the theory of evolution by mutation.

"We find that when two varieties that differ in some characteristic are crossed it frequently happens that one only of the two forms will reappear in the offspring (viz., the *dominant* characteristic, of Mendel), and it will be little modified by the presence, in that offspring, of the germ of the opposite characteristic. This is in accordance with the theory that most characteristics are, or may be resolved into, elementary units. . . . Similarly, when a variety that has some new feature not possessed by the ancestor is crossed with that ancestor the offspring usually have the character fully developed (dominant). If these offspring are crossed together the character is absent in a small proportion only, on the average one-quarter, of their offspring. . . ."

"The fact that in crossing varieties their dissimilar characters do not blend is important, since it supports the theory that such characters first appear as they now are, fully formed. It indicates that since evolution has advanced by the addition of new characteristics it has advanced by steps or jumps. A new species has not *gradually* arisen from an old one, but suddenly, by mutation."[1]

THE NATURE OF EXPERIMENTS IN DESCENT.

But if the facts of Mendelism are examined somewhat more closely and in the light of modern knowledge of the peculiar nature of the reproductive processes of the higher plants and animals, it will be found that the definite mathematical relations which appear in a Mendelian experiment arise from the methods of reproduction rather than from the methods of inheritance. Other interpretations are possible, which render entirely unneces-

[1] Davenport, C. B., 1906. Report on Experimental Biology, Yearbook No. 5, Carnegie Institution of Washington, D. C., p. 94.

sary the more general inferences which have been drawn from Mendelism, such as the existence of character unit particles and the purity of germ-cells.

Instead of being a simple process of making two successive combinations or crosses, of like nature, but with constantly different results, the reproductive processes involved in a Mendelian experiment are highly complex, and very different from what is commonly supposed. Before the bearings of Mendelism on the general problems of descent and evolution can be appreciated, it is necessary that the components of the phenomenon be clearly distinguished.

PARENT ORGANISM PRODUCE PARENT GAMETES.

It is customary to say in describing Mendelian experiments that a cross was made of two individual plants or animals representing certain contrasts of characters. But this simple statement may carry us at once on to false ground, unless we follow closely the details of the process. What we refer to as crossing the plants or animals is merely bringing together the gametes or sex-cells which these particular organisms have produced. The organisms themselves are not involved in the experiment, except to the extent that they have furnished the sex-cells and provided nourishment for the embryos to which the sex-cells give rise. It is the sex-cells or gametes with which the experiment in crossing really begins. They are the true parents of the cross, rather than the organisms selected as parents. Gametes do not belong to the same generation or conjugation period as the parent organisms, but represent a new generation which is already begun before the intention to make a Mendelian or other cross can become effective.

PARENT GAMETES PRODUCE CONJUGATE ORGANISMS.

The union of the gamete parents opens the way to the development of a new organism, which it is customary to consider as the first generation of the desired cross. But again we may ask, what are the detailed facts of the case?

The prevalent view has been that the production of a new organic individual is the result of a conjugation, a complete

fusion of the parent sex-cells or gametes, but this is only partially true among the higher plants and animals. Among the lower groups of sexual organisms no distinction is to be made between conjugation and fertilization, but among the higher types fertilization (the union of sex-cells which initiates the development of a new plant or animal), no longer represents the whole process of conjugation, but only the first part of it. The outer protoplasms of the sex-cells have fused, and also their nuclei, but the conjugation is not yet complete, for the fertilized egg-cell still retains a double equipment of chromatin, derived from the two parents. And since this chromatic material represents the most highly specialized and active form of protoplasmic substance, it is proper to hold that the fertilized egg-cell and all its subdivisions are double cells as long as they contain this double equipment of chromatin.

The gametes can be thought of as persisting through the whole life-history of the individual organism, and do not become finally and completely united until the chromatin has fused in mitapsis, preceding the formation of sex-cells for the next generation. All the cells formed between fertilization and mitapsis are double in the above sense, that they contain two complete sets of chromatin elements, derived from those of the parent gametes. Organisms built up of cells formed while conjugation continues, that is, between fertilization and metapsis, may be called conjugate organisms. After the chromatin has fused in mitapsis new gametes are formed with single equipments of chromatin, capable of undertaking new conjugations. Then the number of chromosomes is again doubled, and the vegetative subdivisions of the conjugating cells are resumed.

CONJUGATE AND EXJUGATE REPRODUCTION.

There is thus a fundamental difference between the reproductive processes of the lower types and the higher. The cells which compose the bodies of the higher organisms are of this double or persistently conjugate character. Reproduction is still a process of cell-divisions, since it is only by cell-divisions that the cellular bodies of plants and animals can be built up. But in the higher types conjugation is not finished before these

reproductive subdivisions occur. It is not until the sex-cells for the next generation are to be formed that conjugation is resumed and brought to a conclusion by mitapsis.[1]

Among the lower groups new organisms are built up at this stage, after conjugation has been completed by mitapsis, and before a new conjugation begins, as in the mosses, liverworts, and lower algæ and fungi. But the higher plants and animals do not attempt to build up structures of these simple cells which are the products of completed conjugations. Instead of forming cellular structures in the intervals between conjugations, the process of reproduction in the higher types hastens from one conjugation to another, as though the superiority of the double cells for structure building were clearly recognized.

The ferns may be cited as an example of a group in which two different structures are built. A little liverwort-like prothallus is formed after conjugation, and a large leafy structure, or frond, during conjugation. Flowering plants, however, have closely approximated the reproductive methods of the higher animals. They do not waste time in structure-building cell-divisions after or between conjugations, but pass promptly from one conjugation to another.

Applying these facts to our experiment in Mendelism, we find that the process of reproduction, as conducted by the higher plants and animals, does not permit of a complete conjugation before the building up of the new organisms which we have been describing as the first generation of the cross we intended to make. Another discrepancy between words and facts has to be admitted. Just as we found ourselves unable to cross the original parents, and were obliged to content ourselves with the intention of combining gametes produced by those parents, so we have now encountered a new limitation, inherent in the methods of reproduction followed by the higher plants and animals. We are unable to bring about an immediately complete union of

[1] The third and final stage of the process of conjugation has been named mitapsis from the Greek words meaning thread-fusion, because the chromatin granules, supposed to represent the two original parents, are, at least in some striking cases, stretched out in long threads. This permits them to fuse in pairs and thus to achieve a much more thorough and complete union than by any less definite method of combination.

the gamete parents, but must wait for them to build up a new organism, which is not a true cross or product of conjugation, but a reproductive by-product, so to speak, which has been intercalated into the experiment which we originally intended to perform. The further progress of our desired conjugation is meanwhile suspended, and remains in abeyance until preparations are made for the production of the next generation of sex-cells. The results we were seeking, as a means of testing the inheritance relations of the characters of the original parental organisms, have not yet been attained.

CONJUGATE ORGANISMS PRODUCE PERJUGATE GAMETES.

The organisms built up by the parent gametes while in the conjugate condition may be called *conjugate organisms*, or *conjugates*. The next generation may be termed the *perjugate generation* to indicate that it has passed through conjugation. The gametes which produce this generation are *perjugate gametes*, and are the first result of the completed conjugation of the original gamete parents. The organisms which these gametes build up afford our first visible evidence of the relations which the parental characters have assumed as a result of conjugation.

What we have been calling the first generation of offspring of such a cross is thus found not to be a true result of the cross, but a structure built of double or conjugate cells which represent vegetative subdivisions of the gamete parents before their conjugation has been completed. What we have been calling the second generation of the cross is really the first generation of the organisms which represent the results of a true union or completed conjugation of the original gamete parents.

With reference to the next preceding generation each sexually reproduced higher plant or animal is a conjugate, that is, it is built up by conjugating gametes derived from the preceding generation. With reference to the second preceding generation each individual is to be reckoned as a perjugate, that is, it represents the result of the completed conjugation of the gametes derived from the second preceding generation. The relation of an organism to the grandparent generation is distinct and different from its relation to the parent generation. It is pro-

duced before the conclusion of the conjugation of the gametes derived from the parent generation, but is the product of the completed conjugation of the gametes derived from the grandparental generation.

Though we may for some purposes make a contrast between the two generations, describing one as conjugate and the other as perjugate, this should not cause us to forget that all organisms of the higher groups are conjugate organisms. This is in fundamental contrast with the exjugate organisms of the lower groups, which are built up, not during conjugation, but in the intervals after, or between, conjugations.

This system of reproduction of the higher plants and animals, which enables them to build up new organisms while conjugation continues, and before it is completed, is responsible for the ability of the higher groups to form sterile hybrids, that is, hybrids between groups which are so diverse that their gametes are unable to effect a complete conjugation, so that no perjugate generation is produced. Such conjugate hybrids are an impossibility, of course, among the lower groups where conjugation has to be completed before cell-divisions begin.

Thus Mendelism is not the only phenomenon which results from the fact that higher organisms are built up before the conjugation of the parent gametes is completed. Conjugate hybrids prove that the conjugate relation is different and less exacting than the perjugate relation, and may thus help to reconcile us to the fact that differences between the two generations are inherent in the method of reproduction and not necessarily indicative of general principles of inheritance. Indeed, it is claimed by some Mendelians, such as Castle and Allen, that dominance, the relation sustained by the gametes in the conjugate generation, has nothing to do with what they consider Mendelism proper, the "principle of gametic purity."[1]

[1] Castle, W. E., and Allen, Glover M., 1903. Mendel's Law and the Heredity of Albinism. Mark Anniversary Volume, pp. 383. Henry Holt and Co., N. Y.

"The principle illustrated by these examples is, as pointed out by Bateson, the most fundamental and farreaching of the Mendelian ideas. It is known as the "law of segregation," or "splitting" of the parental characters at gamete-formation, or as the "principle of gametic purity." Dominance is purely a secondary matter; it may or may not occur along with segregation, though the

SUMMARY OF THE FIVE ELEMENTS OF DESCENT.

Every test of the behavior of different parental characteristics in crosses or hybrids involves these five cases or elements, which may be summarized briefly as follows:

1. *Parent Organisms.* — The individual organisms selected for the experiment in crossing.

2. *Parent Gametes.* — The sex-cells produced by the parent organisms which are brought together to test the results of conjugation.

3. *Conjugate Organisms.* — The organisms which are built up after the parent gametes have united, but before their conjugation is completed.

4. *Perjugate Gametes.* — The gametes produced by the conjugate organisms, representing the first results of a completed conjugation of the gamete parents.

5. *Perjugate Organisms.* — The organisms formed by unions of perjugate gametes, representing the first generation of organisms resulting from a completed conjugation of the gamete parents.

Even the simplest experiment in Mendelism involves consideration of at least these five distinct periods of existence. The adult organisms of three generations are included, and the gametes or sex-cells of two generations. One generation is required for the conjugation of the gametes of the original parents to be accomplished, and another generation for the results of the combination to be brought to expression in adult form. The third generation differs profoundly from the previous generation in its relation to the original parents of the cross, and not merely in the proportional representation of the parental characters, as shown in experiments in Mendelism.

latter can be more easily demonstrated in cases where it is associated with the former. The principle of gametic purity rests upon the assumption that gamete formation is the reverse of fertilization. In fertilization gametes A and B unite to form a zygote AB; when this zygote in turn forms gametes, they will be again A and B. From a knowledge of the *somatic form* alone of pure A's and B's, one can make no trustworthy prediction as to the form of AB. . . . But, no matter what the somatic form of AB is, we may with confidence predict that its gametes will be essentially pure A's and B's, and in equal proportions. This is the Mendelian expectation in all cases of alternative inheritance. Whether it applies to other cases also, and, if so, to what extent, is not yet known."

MENDELISM AS A METHOD OF DESCENT.

By means of these five categories, it is possible to describe Mendelism, as well as other methods of descent, in a more direct and definite manner. Thus Mendelism may be defined as a method of descent which yields conjugates all like one parent, and perjugates like both parents in the proportion of three to one. But to clearly understand the status of Mendelism as a method of descent it is necessary to compare it with other methods, described in corresponding terms. To make formal definitions and laws of Mendelism in the absence of any formulation of other methods of descent, is to only apply another way of claiming unique significance for this one group of phenomena, to the exclusion of others equally worthy of our attention. When the matter is thus brought to a definite issue it becomes evident that there are numerous methods of descent instead of one or two. Indeed, so many methods are now known that a general classification or arrangement of them becomes almost necessary.

Such a classification of methods of descent seems likely to afford a better means of comparison than by attempting to formulate a series of new principles to correspond to the more abstract presentations of Mendelism which have been made. Our so-called natural laws and principles represent, after all, only sequences, processes or groups of phenomena. To call anything a law or a principle is to bespeak for it a somewhat superstitious reverence inconsistent with the thoroughly concrete methods of treatment which afford the only assurance of permanent scientific results. Principles and laws are abstractions, but processes are sequences of relations between tangible things. Mendelism is one of these processes or methods of descent, but it is not the only method, nor the most frequent or important method. Nor does it differ in any very serious or important respect from other methods of descent with which we are all familiar.

PRIMARY METHODS OF DESCENT.

The tendency of the past has been to seize upon one or another of the methods of descent as typical, and then to try to prove that it includes or represents all the others. One way

of avoiding this confusion of unlike conditions is to keep in mind the fact that different kinds of crosses may differ, not only in the particular differences or amounts of difference which the parent organisms show, but also in the fact that the parents may belong to different kinds of groups.

Thus if there is indiscriminate individual diversity, among the members of the parent group (as in a natural, freely interbreeding species) this diversity will not disappear at once, even though care be taken to bring together as parents two individuals which seem to be closely alike. But by selection a uniform type may be bred in which the traditional ideal of heredity, that like produces like, may appear to be fully exemplified. And yet if the narrow breeding be carried on with persistence, mutative reactions toward greater diversity will appear, and these sudden deviations from an established heredity are even more different than were the normally diverse individuals of the original species.

Mendelism belongs to another series of methods of descent, in which the parents are diverse in a more definite manner, that is, by discriminate or regularly established differences, like those existing between the sexes of a species or between selected varieties. Finally, there is the still more fundamental diversity between species which have been separated long enough for definitely divergent characters to be developed.

SYNOPSIS OF METHODS OF DESCENT.

Descent with unrestricted, indiscriminate diversity (heterism).
  Genetic variation in unrestricted descent (neism).
Descent with restricted diversity (heredity).
  Discontinuous variation in restricted descent (mutation).
  Reappearance of ancestral characters (atavism).
Descent with discriminate intraspecific diversity (ropism).
  Descent with integradation of differences (scalar).
  Descent with preservation of differences (polar).
    Polar inheritance in dimorphic species.
      Sexual dimorphism.
      Semisexual dimorphism.
      Subsexual dimorphism.

Supersexual dimorphism.
Diversity in social organisms (politism).
Polar inheritance in crosses of narrow-bred varieties.
Equipolar inheritance.
Partial dominance.
Complete dominance (mendelism).
Interpolar inheritance.
Mosaic inheritance.
Extrapolar inheritance.
Conjugate reversion.
Perjugate reversion.
Prepotent polarity.
Descent with averaging of differences (intermediate).
Descent with specific diversity (hybridism).
Sterile or mule hybrids (conjugate hybridism).
Fertile hybrids between species (perjugate hybridism).

Unrestricted Descent with Normal Diversity (Heterism). — Heterism is a method of descent in which the parent organisms are members of an individually diverse, freely interbreeding group, and the offspring reproduce the group diversity, instead of being restricted to the expression of characters of the parent individuals. Heterism is the most general condition or method of descent, that found in widely distributed, broad-bred species in nature.

Reasons have been given in other places for believing that organic evolution is a function of normal, specific networks of descent — a process of change in a broad fabric of interbreeding lines of descent.[1]

Inheritance, like descent, is a group phenomenon. Uniformity of inheritance is proportional to the uniformity of the group to which the parent organisms belong. In broad-bred groups parent organisms are usually unlike. The offspring are also unlike, and they do not merely reproduce the differences of the parents, but share the indiscriminate individual diversity of the group. Even the simultaneous offspring of the

[1] Cook, O. F., 1906. The Vital Fabric of Descent. Proc. Washington Academy of Sciences, 7: 301. Aspects of Kinetic Evolution. Proc. Washington Academy of Sciences, 8: 197–403.

same parents are often definitely unlike, thus showing that these differences arise from the method of descent, and do not depend merely upon the influences of external conditions.

Genetic Variation with Unrestricted Descent (Neism). — Neism is a form of descent in which the parent organisms have the usual individual diversity of the group to which they belong, while the conjugates and perjugates are more diverse than usual, and differ from the remaining members of the group in the manifestation of a new character.

Uniformity of Restricted Descent (Heredity). — Heredity is a method of descent in which the indiscriminate individual diversity of heterism has been eliminated by narrow breeding or selective restriction of descent. In this way relatively great uniformity may be brought about and maintained for a long series of generations.

To treat heredity as but one among many forms or methods of descent may appear unusual, or even unwarranted. This is because heredity — the production of like by like — has been considered the typical method of descent under theories which hold that differences among the members of a species are not normal phenomena of descent, but due to external conditions. The popularity of this doctrine of normal uniformity in descent has been so great that descent and heredity have often been used as completely synonymous terms, just as it is now proposed by some to extend the inferences drawn from Mendelian inheritance over the whole field of evolution. Under the present interpretation of the facts other methods of descent are recognized as more general and more normal than the production of like by like. Descent is a wider term than heredity, since it includes all the methods of propagation by which organic series are maintained.

Heredity, in the more definite sense, is a fact, but only under conditions of restricted descent. It is only among our narrow-bred domesticated varieties of plants and animals, or among similarly limited groups in nature, that like produces like in any manner which approximates uniformity, so that the descendants may appear "perfectly true to the physical characters of their progenitors." And even this artificial uniformity of restricted

descent is not permanent, but gives way in time to the diversity of mutative degeneration.

Abrupt Variation in Restricted Descent (Mutation). — Mutation is a method of descent in which the parent organisms are alike, but abrupt differences appear among the offspring, usually as the result of variations of the parent gametes.

The parent organisms are not only alike with respect to some particular character, but belong to the same series of like individuals, in which like has produced like for numerous generations.

If the new character is dominant it becomes apparent among the conjugates, but if recessive it can not attain expression unless two recessive gametes can be brought together, which is not possible until the perjugate generation. Mutations differ from genetic variations in the conditions of uniformity and restricted descent in which they appear, and usually also in the greater amplitude of the differences acquired by mutation.

Mutative variations are usually preserved by polar inheritance, and the new character may be either dominant or recessive, quite as in Mendelian crosses of mutative varieties. The condition of restricted descent in which mutations appear is also the condition in which polarity of inheritance is most pronounced, as though an effort were being made to restore the normal diversity of the group, by preserving all of the mutative differences.

Atavism. — Atavism is a method of descent in which the offspring diverge from the parents and their immediate relatives in the expression of a character in some more remote ancestor. Thus many mutative variations of narrow-bred domesticated varieties are in the direction of characters of the wild type of the species. Atavism is related to reversion, but a distinction may be made by calling those cases reversion in which the return to the ancestral character has been occasioned by the interbreeding of members of two or more narrow-bred varieties.

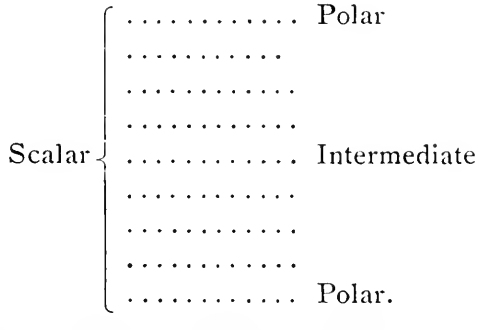
Descent with Discriminate Diversity. — Discriminate inheritance includes those forms of descent in which the parent organisms represent narrow-bred groups, so that their differences are not merely individual or indiscriminate. The different methods of descent in discriminate inheritance can be con-

veniently illustrated by thinking of the characters of the two parents as the ends of a graduated series or scale like that of a thermometer. With reference to such a scale three forms of discriminate descent may be distinguished.

In the first form the offspring present a complete series of gradations between the parental extremes. This may be called scalar or intergraded inheritance. It resembles most nearly the indiscriminate diversity of descent of natural species.

In the second form of discriminate descent the progeny, and especially the perjugate gametes, are adjusted to favor the complete preservation of the divergent parental characters, or poles of the series, but do not produce the connecting series between.

In the third form of discriminate descent the divergent characters are not preserved by separate expressions, but are combined into an intermediate average.



Inheritance of Intergradations (*Scalar*). — Scalar or intergraded inheritance is a method of descent in which the offspring show a complete series of gradations between the divergent characters of the parents. The result of such crosses is to release again the normal tendency to diversity, so that the pendulum of variations swings over the entire series of gradations between the parental poles of the scale of inheritance.

With reference to their expression in any single individual the two parental characters may be said to be combined or blended, but the existence of a complete series of gradations is the characteristic which distinguishes this method of descent from the combinations which result in a uniform or intermediate

average, and those in which the parental diversities are preserved by alternative expression. Nor is it to be supposed that there are not conditions intermediate between scalar, polar and intermediate inheritance. In some characters there may be a tendency to prefer the extremes of the series, and in others the mean, or some other maximum point. Such relations have been investigated at length by Galton and other statistical biologists.

Scalar inheritance is in some respects intermediate between indiscriminate inheritance and polar inheritance. The parental diversities become established as the poles of the series, but the polarity is not so definite as when the parental differences are fully preserved.

Scalar inheritance is commonly manifested in crosses between selected varieties of domesticated plants and animals. It was formerly taken for granted that similar series of intergradations were often produced in nature by the hybridizing of species, but the evidence has failed to convince the late G. C. Churchill, an English botanist who appears to have given this particular point very extensive and discriminating study.[1]

The fact seemed to be established that in the great majority of cases, at least, the hybrids between adjacent species of gentians and other alpine plants were limited to one or two definitely intermediate forms, without series of connecting links or intergradations (*Uebergangsformen*). The ability to form intermediate sterile hybrids would not really intermingle the species or interfere with their continued differentiation. Less differentiated species with separate geographical ranges might form intergraded crosses like selected varieties of the same species, but it is not to be supposed that species which freely interbreed and intergrade, could become differentiated while occupying the same geographical distribution. Whenever two related, but definitely distinguishable species occupy the same area we may expect to find that they have some other form of segregation, such as differences of time of flowering, or inability of the germ-cells to effect normal conjugations.

Descent with Preservation of Differences by Polar Inheritance. — Polar inheritance is a general type of descent which in-

[1] Churchill, G. C., 1906. Quotations in Obituary Notice, Kew Bulletin, No. 9, 1906, 384.

cludes all cases in which the parent organisms differ by two or more characters which are preserved in the offspring. All species in which definite diversities are maintained like those of sexes, castes, dimorphism, polymorphism, etc., are examples of polar inheritance, as are also the crosses of different varieties when the parental diversities are repeated in later generations. The general opinion has been that when two unlike individuals are bred together their differences tend to average away or come to an intermediate point in the offspring, but this is not true when descent follows the methods of polar inheritance.

The diverse characters of the parent organisms continue to be represented in the perjugate gametes and the perjugate offspring, instead of being lost by intermediate or graded inheritance or other more miscellaneous variations. In several forms of polar inheritance equal numbers of the perjugate gametes represent the divergent parental characters, but there is great diversity in the relations assumed by the parent gametes, as shown by diversity of behavior in the conjugate generation.

Polar Inheritance in Dimorphic and Polymorphic Species.— Two conditions of polar inheritance may be distinguished, those in which the polarity is already established under conditions of free interbreeding and those in which relations of polarity are manifested when representatives of different varieties and species are bred together. In the one case the polarity is altogether natural, in the other somewhat artificial or experimental. That there is any essential difference in the nature of the polarity phenomena of the two series of cases, is scarcely to be claimed, but it is very desirable to distinguish them in attempting to estimate correctly the general significance of the polarity phenomena.

Polar Inheritance of Sexual Differences (*Sexual Dimorphism*). — The most familiar phenomenon of polar inheritance is that of sex. The parents are diverse, often by a large series of definitely contrasted characters, and the offspring, both conjugates and perjugates, preserve all these contrasts. Sex-inheritance differs from Mendelism mostly in being a much more specialized form of the same phenomenon of polarity in the expression of divergent characters.

Semisexual Dimorphism. — Semisexual dimorphism is a

method of descent in which the members of the same species of two definite kinds or castes, so formed as to require or to facilitate cross-fertilization, though without the separation of the sexes in different individuals. The differences found in semisexual species correspond in all respects, to the secondary sexual characters of completely sexual species, except that they do not accompany sex-differentiation. Examples of semisexual dimorphism are numerous among plants, as in the species of *Primula*, *Houstonia*, etc. In some species of *Oxalis* and *Lythrum* there is even a trimorphism involving three kinds of stamens, pistils and pollen-grains.

Subsexual Dimorphism and Polymorphism. — Subsexual dimorphism is a method of descent in which the members of the same species are of two or more different kinds, castes or "elementary species", but without regard to sexuality or to provisions for cross-fertilization. The phenomenon may prove to be completely analogous with Mendelism and other related forms of polarity of character-expression in crosses between narrow-bred varieties. It is, in short, polar inheritance under natural conditions of free interbreeding, not complicated by the more highly specialized polarity of sex-differentiation.[1]

A recently recorded addition to this series of phenomena is that of a color-diversity in *Verbena stricta*, discovered in Kansas by Professor Schaffner.

"The peculiar form which I discovered was very different from the type and its variants. The color of the corolla was a pinkish-white [instead of deep purplish blue] and the individuals, numbering several thousands, were found to be remarkable for the uniformity of this character. There were no transition forms whatever. The mutant had a much smaller color variability than the parent species, and no other peculiarity than the color of the corolla was discovered.

"The mutants covered about a square mile of territory. In some directions, however, they have advanced for nearly a mile beyond what seems to have been the center of distribution. . . . The mutant was found indifferently on nearly all kinds of soil

[1] Examples of Semisexual, Subsexual, and Supersexual differentiations are given in Cook, in Aspects of Kinetic Evolution. Proc. Wash. Acad. Sci., 8: 320–376.

and habitat which the section afforded. In some places the normal type was more abundant, in others the mutant, while in still other spots both were present in about equal numbers, growing together closely intermingled. . . .

"This mutant is not of hybrid origin. Hybrids between certain species of *Verbena* are common but are easily recognized from morphological characters. No hybrids were found in the locality. A careful search was made in all directions. . . ."[1]

A new character is obviously analogous to a mutation, though it does not behave as mutations are supposed to do. At present it seems to have brought about a condition of dimorphism in the parent species, instead of requiring to be isolated in order to be preserved, though the possibility of segregation by some form of reproductive incompatibility is not absolutely excluded.

Supersexual Dimorphism. — Similarly definite diversities of color are also known among sexually higher differentiated animals, and may be reckoned as constituting still another method of descent, *supersexual dimorphism*. The present interest of this phenomenon lies in the fact that it proves that polarities of expression may be maintained even in sexually differentiated species and under conditions of free interbreeding. The diversities of eye-color in the European races constitute a mild form of such a dimorphism or alternative inheritance phenomenon, as shown by the studies of Galton.

Diversity in Social Organisms (Politism). — Politism is a method of descent in which a part of the offspring regularly show characters different from any of their parents or ancestors, accompanied by a deficient development of the sexual organs and powers of reproduction, as in the highly socialized groups of insects, such as the ants and the termites. Politism differs from other kinds of dimorphism in that the offspring represent from one to four specialized sterile castes, in addition to the reproduction of the unspecialized sexual types.

Character-transmission is here completely divorced from character-expression, for the sexual insects never express the characters transmitted to the sterile castes, nor do the sterile castes propagate their own characters or those of their parents. That

[1] Schaffner, J. H., 1906. A Successful Mutant of Verbena without External Isolation. Ohio Naturalist, 7 : 31.

the characters which a particular individual shall express as an adult may be determined by external conditions constitutes additional evidence that the expression of characters does not depend upon the same factors as the transmission of characters. Cases of politism occur also among plants. The vegetative internodes, which correspond to the neuter individuals of the insect colonies, may become unlike. Some of the branches are then unable to replace the main stem, though in most plants all the branches and internodes are potentially equal.

Polar Inheritance in Crosses of Narrow-Bred Varieties. — The general result of this class of experiments has been to prove that narrow-bred varieties may assume the same or very similar relations of polar inheritance as those regularly manifested by the sexes and castes of dimorphic species. Indeed, the narrow breeding which has restricted the descent of the parental groups appears to intensify the polarity phenomena in such a way that very definite mathematical relations are sometimes assumed.

Equipolar Inheritance. — Equipolar inheritance is a method of descent in which the diverse characters of the parents are expressed in equal numbers of the conjugates and perjugates, just as in sex-inheritance. This shows that the diversities are also represented in equal numbers of the gamete parents and the gamete offspring, but they are not united with the sexual characters. There are many secondary sexual characters which are to be distinguished from equipolar characters only by this relation to sex-differentiation.

Instances of equipolar descent like that of Professor Davenport's cross between the four-toed and five-toed chickens are of special interest as connecting links between sex-inheritance and other forms of polarized descent. Thus if Professor Davenport were to mate five-toed cocks with four-toed hens for a series of generations we may expect that the five-toed character would become definitely attached to the other polarities of sex-inheritance, just as the enlarged spur is now a part of the regular, normal equipment of the male birds.

Some of the mutations of the coffee tree are purely pistillate and some purely staminate. If a dimorphic type of coffee were desirable it would probably not be difficult of development by breeding from such a pair.

That polarity of inheritance also exists in nature apart from sex-inheritance is shown in numerous instances of dimorphism and dichromatism. Some animals have dichromatism superposed upon sex, and many plants are dimorphic in which the sexes are not separated.

Partial Dominance. — Partial dominance is a form of polar inheritance in which the diverse characters of the parents are brought to expression in unequal numbers of the conjugates and perjugates. The relation between the parent gametes is not uniform, one of the divergent characters gaining expression as a dominant in one conjugate individual, but remaining abeyant in another. Nevertheless, the gametes formed by these unlike conjugates may follow the law of polar inheritance. Equal numbers of gametes would then represent the expression of the divergent parental characters, though the partial dominance of the conjugate relation would again affect the proportion in which the characters would be expressed among the perjugate organisms.

A good example of partial dominance is to be found in crosses between *Œnothera lata*, one of De Vries's mutations, and the parent type *O. lamarckiana*. About 15 percent show characters of *O. lata*, that is *O. lata* is dominant to the extent of 15 percent, *O. lamarckiana* to the extent of 85 percent. As this mutation does not itself produce any pollen, its characters must be considered as receiving expression only in this condition of partial dominance. The instance is interesting because of the further fact that the *lata* mutation has very recently been found to have only 14 chromosomes in the somatic cells, while the *lamarckiana* form of the cross has at least 20.[1] This shows that dominance, at least, does not depend upon the number of chromosomes.

There is no assurance, of course, that a character once recessive is always recessive, or that the proportions of expression may not change. Even in Mendelian experiments different crossings of the same stocks often show different results, as in the case of the tailless fowls and other deviations from the Mendelian expectations described by Professor Davenport.

[1] Gates, R. R., 1907. Preliminary Note on Pollen Development in Œnothera lata De Vries and its Hybrids. Science, N. S., 25 : 259, and Bot. Gaz. 44 : 1–21.

None of the 200 offspring of one of the tailless birds was tailless, but in the progeny of a son of the same bird the tailless character gained expression in the regular Mendelian proportions.

Complete Dominance (*Mendelism*). — Complete dominance, or Mendelism, is a form of polar inheritance in which only one of the divergent parental characters (dominant) is expressed in the conjugates, but the perjugates are like both parents in a proportion of three to one. The parent organisms and gamete parents are diverse with respect to the expression of one or more definitely contrasted characters. The conjugates show the divergent character of only one of the parents, which is called the dominant. The perjugates are again diverse like the parent organisms, but the expression of the divergent characters of the organic parents is unequal, three-quarters having the dominant character expressed in the conjugates, and one-quarter the character which was recessive or abeyant in the conjugates. Subsequent generations will continue to reproduce the latter, three dominants to one recessive. Thus Mendelism might be reckoned as a weaker form of sex-inheritance in which the phenomenon of dominance interfered with a strict equality of expression-polarities in the conjugate phases.

The inferences which have been based on the differences of proportion in the expression of the parental characters of the so-called first and second generations of a Mendelian cross fall to the ground as soon as we consider in sufficient detail the reproductive processes by which they are produced. The two generations have an entirely different relation to the original organisms or to the gamete parents, but at the same time the relation of the characters to each other is not different in the generations, in spite of the difference of proportions. In the conjugate generation all the organisms arise from combinations of unlike gametes, while in the perjugate generation only half of them represent such combinations. But all of these show the phenomenon of dominance, quite as in the first generation. The behavior of first generations proves to us that characters may be expressed by polarity, or as reciprocals, instead of as averages or resultants. If we admit the same possibility for

the expression tendencies of gametes the mathematical relations of Mendelism can all be understood without the necessity of predicating character-units or pure germ cells.

Dominance, as a manifestation of expression-polarity, is not a merely secondary matter in Mendelism, but affords a key to the whole phenomenon, since it renders unnecessary the false assumption that gamete formation is the reverse of fertilization.

Interpolar Inheritance. — In interpolar inheritance one of the divergent characters is not dominant over the other, but the two characters receive intermediate expression in all of the conjugates and in one half of the perjugates.

This shows that the gametes formed by the intermediate conjugates represent the divergent parental characters in equal numbers, as in Mendelism, but the lack of dominance leads to intermediate expression of characters in the conjugate generation, and in one half of the perjugates and other succeeding generations, since half of the gametes may be expected to mate with others having the same polarity, and half with those having a different polarity.

Mosaic Inheritance. — Mosaic inheritance differs from interpolar inheritance in that the divergent characters are not completely averaged or blended, but pieced together, as it were, after the manner of a mosaic. Thus in crosses between black and white poultry, interpolar inheritance brings a conjugate generation of an intermediate gray or blue color, while mosaic inheritance yields larger or smaller spots of black and white.

Mosaic inheritance might also be compared with scalar inheritance.

Extrapolar Inheritance. — Extrapolar inheritance is a form of descent in which conjugate organisms present characters diverse from those of the parents, instead of being like either parent or intermediate between them. Such divergent conjugates are called heterozygotes in the specialized vocabulary of Mendelism. The fact that such characters depend for their expression, not on the polarity possessed by the gametes before conjugation, but upon the relations assumed during conjugation, enables us to understand the general opinion of Mendelists that heterozygote characters cannot be "fixed" by selection. Simple

selection might have, it is true, no tendency to render such a conjugate character transmissible, but the chance that gametes might be found which tended to the same expression as the conjugates might warrant such an effort if the heterozygote character was sufficiently valuable.

Whether any heterozygote characters represent really new variations seems not to have been definitely ascertained. In case they should all prove to be in the nature of reversions this method of descent will coincide with the next.

Conjugate Reversion. — Conjugate reversion is a form of descent in which the conjugates become different from both of the parent organisms by returning to the expression of an ancestral character of one or both of the parents. Thus Darbishire reports that numerous crosses of two varieties of pink-eyed mice yielded only black-eyed offspring in the first or conjugate generation.

Perjugate Reversion. — Perjugate reversion is a method of descent in which the conjugates do not depart from the characters of the parents, but the perjugates become abruptly different by returning to the expression of an ancestral character. Perjugate reversion differs from conjugate reversion in that the ancestral character reappears in the perjugate generation, instead of in the conjugate generation.

Perjugate reversion may be illustrated by an experiment reported by Dr. Herbert J. Webber. The crossing of Sea Island cotton with a smooth-seeded Upland variety resulted in a conjugate generation which was smooth-seeded like the parents, but in the second or perjugate generation woolly seeds reappeared, and for several generations afterward.[1]

Both kinds of reversion may be considered as due to a restora-

[1] "Where the smooth-seeded Klondike upland was used in crossing with Sea Island the second generation hybrids exhibited a very peculiar case of reversion. The Klondyke, while originally a fuzzy-seeded type, had been carefully selected for a number of generations before the crossing was done, until it produced regularly and normally a smooth black seed. When crossed with Sea Island the first generation hybrids all had smooth black seeds. In the second generation, however, quite a number of the progeny had fuzzy seed, showing that the fuzzy seed potent still existed in the Klondike though dormant. This would seem to be an important point, as indicating the non-purity of the germ-cell." Webber, H. J., 1905. Cotton Breeding. Proc. Amer. Breeders' Association, 1: 40.

tion of polarity of expression to an ancestral character which has remained latent for numerous generations. In conjugate reversion the change of polarity comes about through the bringing of the gametes together in fertilization. In perjugate reversion the change of polarity probably occurs at mitapsis, when the new gametes are formed. Perjugate reversion may also be described as mitaptic reversion or as gamete reversion, when it is desired to emphasize these contrasts. But from the standpoint of analogy with Mendelism perjugate reversion seems the better term, since it indicates more definitely the fact that the reappearance of the previously latent ancestral character does not become evident in the conjugate generation, but in the perjugate.

A curiously complex instance of reversion in later perjugate generations has been reported recently in pigs. Two three-quarters Berkskire and Poland China sows, when bred to a similarly crossed male produced litters of pigs each of which showed, while young, seven longitudinal stripes like wild pigs. The parents had retained the black color and white points of the parent breeds. The mating of a pair of the pigs which had been striped when young yielded a diverse litter, some with the ancestral stripes, some with solid sandy black, the usual coloration of the Berkshire breed of sixty years ago, and some with black and white spots like the Poland Chinas of thirty years ago.[1]

Prepotent Polarity. — This is a form of polarized descent in which the divergent character of one parent is expressed in more than three-quarters of the perjugates, showing that more than half of the prejugate gametes tend to express the character of the one parent.

An instance which may be interpreted as polar prepotency is described by Professor De Vries. All the seeds of a plant which had shown only a few ligulate disk-flowers produced plants with completely double flowers. The expression of the double variation may have been restricted in the first generation by the non-mutated gamete, but the new character appears

[1] Simpson, Q. I. and J. P., 1907. Reversion Induced by Cross-Breeding. Science, N. S., 25: 427.

to have been prepotent in all the gametes of the next generation.[1]

Descent with Combination or Averaging of Differences (*Intermediate*). — Intermediate discriminate inheritance is a form of descent in which the differences of the parents are reduced in the offspring to an intermediate blend or average.

The difference between interpolar inheritance and intermediate inheritance is that in the former the intermediate expression of the diverse parental characters is general only in the first or conjugate generation, since the perjugate gametes tend to express the parental characters, as well as the intermediate. But in true intermediate inheritance the gametes also tend to intermediate expression, so that the perjugate generation may be as definitely intermediate as the conjugate. In the language of Mendelism, dominance is lacking, and the germ-cells are not "pure." Both interpolar inheritance and mosaic inheritance will be found, no doubt, to shade off by imperceptible gradations into intermediate or completely blended inheritance. Some of the gradations were well shown in Professor Davenport's poultry-hybrids.

Descent with Specific Diversity (*Hybridism*). — No absolute distinction can be made between crosses of groups which have become isolated by natural causes and those which have become isloted by man; but there is usually this very important difference that conscious human selection narrows the network of descent much more suddenly and definitely than unconscious agencies of the environment. Unconscious selection rejects only the end of the procession, but conscious selection saves only the head, or some other equally restricted section. Species usually do not differ from each other in the same definite ways that narrow-

[1] De Vries, H., 1907. Evolution and Mutation. The Monist, 17: 19.

"The double variety of the corn-marigold (*Chrysanthemum segetum*) arose in my garden in a culture in which I was increasing the number of ray-florets by continuous selection. During four years I had succeeded in increasing this number to about sixty on each head, starting from the cultivated variety with an average of twenty-one. All the ray-florets, however, belonged to the outer rows of the heads, as in the original variety. At once a plant arose which produced some few ligulate florets in the midst of the disc. This indicated the production of a double race. When the seeds of this mutating individual were sown the next year, they yielded a uniformly double group; and from this time the new variety remained constant."

bred mutative varieties differ, and interspecific hybrids usually do not show the same definite polarities of character-expression.

Sterile or Mule Hybrids (*Conjugate Hybridism*). — Conjugate hybridism is a form of descent in which the parent gametes are not able to accomplish a complete conjugation, though they are able to unite in fertilization and build up a conjugate organism. Normal perjugate gametes are not formed, nor any perjugate organisms.

Conjugate hybridism may be illustrated by the mule and other sterile crosses between the members of distinct species, but mutative variations may also be sterile like conjugate hybrids. Usually these sterile conjugate hybrids are definitely and uniformly intermediate between the two parents, as though there were definite tensions which had yielded a uniform resultant. Thus there seems to be rather less diversity among mules than among horses.

Fertile Hybrids between Species (*Perjugate Hybridism*). — Perjugate hybridism is a form of descent in which gametes representing different species are able to perform a complete conjugation, so that a perjugate generation is produced.

There are many stages and gradations between conjugate and perjugate hybridism, and of perjugate hybridism many different degrees might be distinguished. Between some species perjugate hybrids are to be obtained only rarely and are then weak, short-lived or sterile. Where the parental incompatibility is somewhat less, the perjugate generation, though more readily produced, shows a wide range of diversity like that of mutations of narrow-bred varieties. The following generations of such mutative hybrids may also be very unstable, but in plants capable of vegetative propagation these mutative hybrids are often valuable. Other species hybridize with greater freedom, and show less abnormal diversity. Finally, some hybrids between species appear to be nearly as normal and stable as crosses between related varieties of the same species.

Diagram of Methods of Descent.

Methods of Descent.	Parent Organisms.	Mitapsis.	Parent Gametes.	Fertilization.	Conjugate Organisms.	Mitapsis.	Perjugate Gametes.	Fertilization.	Perjugate Organisms.
Heterism.	Indiscriminately diverse.		Diverse.		Diverse like parent group.		Diverse.		Diverse like parent group.
Genetic variation (neism).	Indiscriminately diverse.		Diverse.		More diverse than parent group.		Diverse.		More diverse than parent group.
Heredity.	Alike, narrow bred.		Alike.		Alike.		Alike.		Alike.
Mutation.	Alike, narrow bred.		Diverse.		Diverse.		Diverse.		Diverse, with polar inheritance.
Atavism.	Alike.		Alike or Diverse.		Diverse, some like remote ancestor.		Alike or diverse.		Alike or diverse.
Scalar inheritance.	Diverse groups.		Diverse.		Intermediate intergraded.		Diverse.		Diverse, showing all gradations between parents.
Sexual dimorphism.	Diverse sexes.		Diverse.		Diverse sexes.		Diverse.		Diverse sexes.
Semisexual dimorphism.	Diverse semisexes.		Diverse.		Diverse semisexes.		Diverse.		Diverse semisexes.
Subsexual dimorphism.	Diverse, without reference to sex.		Diverse.		Diverse subsexes.		Diverse.		Diverse subsexes.
Supersexual dimorphism.	Alike or diverse.		Diverse.		Diverse supersexes.		Diverse.		Diverse supersexes.
Politism.	Alike, unspecialized.		?		Unlike, fertile and sterile.		?		Unlike, fertile and sterile.
Equipolar inheritance.	Diverse groups.		Diverse.		Like both parents in equal number.		Diverse in equal numbers.		One-half like one parent, one-half like other parent.

DIAGRAM OF METHODS OF DESCENT.—*Continued.*

Methods of Descent.	Parent Organisms.	Mitapsis.	Parent Gametes.	Fertilization.	Conjugate Organisms.	Mitapsis.	Perjugate Gametes.	Fertilization.	Perjugate Organisms.
Partial dominance.	Diverse groups.		Diverse.		Like both parents in unequal numbers.		Diverse, in equal numbers.		Like both parents in unequal numbers.
Complete dominance (Mendelism).	Diverse groups.		Diverse.		Like one parent (dominant).		Diverse, in equal numbers.		Three-fourths like dominant parent, one-fourth like recessive parent.
Interpolar.	Diverse groups.		Diverse.		Intermediate, blended.		Diverse, in equal numbers.		One-fourth like one parent, one-half intermediate, one-fourth like other parent.
Mosaic.	Diverse groups.		Diverse.		Intermediate, mosaic.		Diverse, in equal numbers.		One-fourth like one parent, one-half mosaic, one-fourth like other parent.
Extrapolar.	Diverse groups.		Diverse.		Different from both parents (heterozygote).		Diverse, in equal numbers.		One-fourth like one parent, one-fourth like other, one-half different from either.
Conjugate reversion.	Alike, but of different origin.		Alike		Different from parents, like remote ancestor.		Alike or diverse.		Diverse, some like parents, some like conjugates.
Perjugate reversion.	Alike, but of different origin.		Alike.		Like parents.		Unlike parents.		Like remote ancestors.
Polar prepotency.	Diverse.		Diverse.		Usually like one parent.		More than half like dominant.		More than three-fourths like dominant.

DIAGRAM OF METHODS OF DESCENT.—*Concluded.*

Methods of Descent.	Parent Organisms.	Mitapsis.	Parent Gametes.	Fertilization.	Conjugate Organisms.	Mitapsis.	Perjugate Gametes.	Fertilization.	Perjugate Organisms.
Conjugate hybridism.	Diverse species.		Diverse.		Intermediate, sterile.		No perjugate gametes.		No perjugate organisms.
Perjugate hybridism.	Diverse species.		Diverse.		Intermediate or diverse, fertile.		Alike or diverse.		Intermediate or diverse like mutations.

POSITION OF MENDELISM AS A METHOD OF DESCENT.

No claim of completeness is made for these condensed summaries and tables. They are introduced at this time only to show the position of Mendelism among other methods of descent. It has been customary to describe Mendelism as a form of heredity, but in reality it constitutes a rather wide departure from the primary concept of heredity, as developed in evolutionary literature. Heredity usually implies the production of like by like, which many have considered the normal process of descent.

Mendelism is one of the methods of descent in which unlike produce unlike. Mendelism has aroused special interest in the scientific world largely because it seemed to contradict the earlier inferences from the idea of heredity, by showing that contrasted differences are preserved, and not reduced to a uniform intermediate average. Instead of being a form of heredity, Mendelism is a specialization of heterism ; it is one of the methods of increasing diversity of descent, which sustains the efficiency of the processes of sexual reproduction. The preservation of differences inside the species by means of sex-inheritance is one of the most familiar phenomena of descent, but the intimate resemblance between Mendelism and sex-inheritance has not been adequately appreciated.

MENDELIAN "PRINCIPLES" NOT DEMONSTRATED.

To explain these phenomena of polar inheritance the Mendelian doctrine of pure germ-cells was invented, but the facts

do not require so extensive an assumption to be made. It is not necessary to suppose that gamete-formation is the reverse of fertilization. The facts indicate only that the perjugate gametes are definitely polarized or predisposed to the expression of one or the other of the divergent parental characters. It may not be entirely inconceivable that pure germ-cells could be formed on the plan of the Mendelian theory if the incompatibility of a hybrid were great enough to prevent mitapsis, but germ-cells which remained pure in this manner would constitute a very abnormal and exceptional phenomenon, like parthenogenesis or apogamy, instead of being a general method of descent.

If the parental protoplasms separated, instead of completing the fusion of the chromatin, the parental characters should segregate in the original groupings and not be found in all varieties of combinations as happens whenever the parents differ by two or more Mendelian characters. The theory of incompatibility is also excluded by the fact that the varieties which afford the best examples of Mendelism are usually closely related members of the same species, and the crosses are entirely fertile.

The Mendelian "principle of gametic purity" has sometimes been described very appropriately as "the law of disjunction", since it rests on a denial of the fact of mitapsis, and holds that no permanent fusion takes place between the gametes which are brought together in Mendelian experiments. The presence in a germ-cell of the element or unit representing one of the divergent characters is supposed to exclude the unit which represents the alternative character.

But even the phenomenon of dominance, the primary fact of Mendelism, shows that the representation of a character in a germ-cell and the bringing of it to expression in an organism are two entirely distinct processes. In building up the conjugate structure the two gametes have a wide range of methods of coöperation. In Mendelism the character of one gamete dominates completely, so that the tendency of the other gamete to the expression of a different characteristic is completely concealed and held in abeyance. And yet Mendelian experiments

prove conclusively that the recessive character may not be lost or diminished by this period of suppression, but may have equal representation in the expression-tendencies of the gametes of the next generation.

Single gametes, like conjugate gametes, may retain and transmit characteristics which they do not express. The reappearance of the blue plumage of the wild pigeons in Darwin's crosses of white varieties, the return of the red and yellow feathers of the wild jungle-fowl to Professor Davenport's black and white chickens, and the uniform production of black-eyed mice as a result of crossing two pink-eyed varieties by Darbishire, are conspicuous examples of this fact, that characters may be brought again to expression after passing in latent condition through many generations of germ-cells.

With this fact definitely established, that it is possible for germ-cells to transmit characters for many generations without bringing or tending to bring them into expression, the Mendelian "laws of disjunction," "purity of gametes," "alternative inheritance," or whatever they may be called, become at once superfluous and inadequate. They are inadequate because they do not explain how a character-unit could once get back into gametes after being left out. They are superfluous because the facts indicate only that gametes have a tendency or polarity of expression of particular characters, though they may at the same time transmit other characters which can regain the power of expression in subsequent generations.

MENDELIAN INHERITANCE OF MUTATIONS.

Belief in the Mendelian assumptions of character-units and pure germ-cells as general laws or principles of descent has been greatly strengthened by contemporaneous activity in the investigation of the phenomena of mutative variation. Mutative variations commonly obey Mendel's "laws." It is not strange that those who have accepted mutations as genuine species should consider the Mendelian "principles of inheritance" as of universal application, and of fundamental significance for evolution.

That there are very direct relations between mutations and

Mendelism can not be denied. Indeed, the relations appear to be still more intimate than even the advocates of the two theories have supposed. Varieties which have arisen by mutation may not only behave in a Mendelian manner when crossed, but mutations may actually represent Mendelian phenomena, at the time of their first appearance.

The nature of the protoplasmic combinations and readjustments which take place during the process of chromatin fusion (mitapsis) is not yet known, but the indications favor the commonly accepted view, that new variations usually occur at mitapsis. As mutations are relatively infrequent phenomena, it would only be in the rarest cases that two newly mutated gametes would meet in conjugation. The general rule must be that new variant gametes conjugate with gametes of the unmutated parental type, and thus have from the first the reproductive status of Mendelian crosses.

There are two ways for such a new gamete variation to gain visible expression in a plant or animal. If the mutation be dominant, it can make itself manifest in the first generation. If it be abeyant, or recessive, expression can be secured only in later generations, when it becomes possible for two of the recessive gametes to be brought into conjugation.

Mutative variations which have arisen under conditions of restricted descent tend to disappear when they are brought into contact with the wild type or with a less inbred stock, but new mutations are often dominant and prepotent when bred within their own group of immediately related organisms. Among Professor Davenport's hybrids the frizzled plumage was dominant, while the silky plumage was recessive.

That mutations may be hybrids already, at the time of their first expression in the conjugate organism, would explain differences of behavior between different kinds of new variations. A dominant variation would not be represented in all the progeny of the second generation. Even though the new variation were a plant which could be fertilized by its own pollen, at least a quarter of the second generation would express the character of the recessive gamete grandparent.

Recessive variations, though they can not secure expression

in the first or conjugate generation, may be expected to be constant or "true to seed" when they have once gained expression. In the language of special students of Mendelism, such a mutation is already a "pure recessive." To secure equally uniform expression of the dominant character it may be necessary to extract the "pure dominants," that is, to select the progeny of parents which produce offspring of the dominant type only.

A dominant mutation will usually make its first appearance as a single individual. A new variation occurring at mitapsis would be represented by only one female gamete, or by four male gametes. A recessive variation may secure simultaneous expression in numerous individuals of the same generation, or may continue to gain apparently independent expression in successive generations. The method of narrow breeding or self-fertilization used by De Vries and other experimenters to insure the purity of their stocks, is well calculated to bring such abeyant or recessive variations into expression.

These considerations may have practical significance in experiments for inducing new mutative variations by hybridization. The first or conjugate generation does not represent the final result of the cross, but only the conjugate relations of the gametes. The variations may be expected to take place in the mitapsis which precedes the formation of the sex-cells for the next generation, but only the dominant variations can gain expression in the second or perjugate generation of the cross.

For a recessive variation to be expressed it would be necessary for two of the recessive gametes to unite in conjugation, and this could not occur in the second generation, in any sexually differentiated species. To insure the expression of the recessive variations which the cross may have induced, it would be necessary to self-fertilize the perjugate generation. The usual custom of breeders of plants propagated by buds or cuttings is to make their selections and close the hybridizing experiment with the second generation. The expression of the recessive variations is thus entirely prevented, for no third generation is produced. With seed-propagated species the diversity caused by the recurrence of reversions continue for numerous generations, until the desired characters have been "fixed" by a course of persistent selection.

The degenerative nature of many valuable variations of domesticated plants and animals is well known, and also their generally recessive status. It might, therefore, be worth while to take into account in experiments with plants this means of bringing recessive characters into expression by the self-fertilization of the perjugate individuals of crosses from which desirable variations are desired.

Numerous analogies between hybrids and mutative new variations have been described and discussed in other places, but the present indications of the possible identity of the phenomena had not been perceived.[1] Mutations not only behave like hybrids, but they may actually be hybrids, the mutative variation having taken place in only one of the gamete partners of the conjugation which has given rise to the variant organism. The partial or complete sterility of many mutations may be quite the same phenomenon as the sterility of many hybrids, and may sometimes be due to the incompatibility of very diverse gametes.

Variations which come true to seed from the very first may still behave as recessives when crossed, since recessive variations do not gain expression except when the gametes are of the same kind. Other variations, though they may not come true, may be dominant, or even prepotent. Thus narrow-leaved mutations of cotton (okra-cottons) which do not come true from seed may show, nevertheless, a definite and uniform prepotency when crossed outside the parent type.

The dominant and recessive relations are not, as some have supposed, evidences of incompatibility or failure of the gametes to accomplish normal and complete conjugation. Indeed, the present perceptions enable a definite distinction to be drawn between terms which are not truly synonymous, though often so used. Dominant and its alternative, recessive, have reference to the relations of gametes as shown in the characters of conjugate organisms. The character which secures expression is called *dominant*, while that which remains abeyant or is not expressed is called *recessive*.

[1] Cook, O. F., 1904. The Vegetative Vigor of Hybrids and Mutations. Proc. Biological Society, Washington, 17 : 83

Prepotency, on the other hand, has reference to the results of completed conjugation, as represented in gametes. Characters which secure a stronger or more general expression in the new gametes are called *prepotent*, those which tend to decline or to disappear may be called *subpotent*. Characters which have equal polarity, so that they each secure an unmodified representation in behalf of the gametes may be called *equipotent*. If these polarities show equal strength in the conjugate relation, so that half of the conjugate organisms also represent each of the divergent characters, we would have a complete case of equipolar inheritance.

Characters which are transmitted without expression-polarity, either in conjugates or in gametes, are called *latent*. An abeyant or recessive character fails of expression only when joined with a dominant gamete polarized toward the expression of another character, but a latent character does not come to expression even when two gametes are of the same kind, though it may still reappear many generations afterward as in atavism and reversion. Latency might be described as character-abeyance in gametes. As a character represented in one of a pair of conjugate gametes may fail to secure expression in the conjugate organism, so the power of bringing a certain character to expression may remain latent in a gamete, as long as the polarity of expression continues to be directed toward another character. Just as the transmission of a character through a conjugate organism has no necessary relation to its expression, so the transmission of a character by a gamete has no necessary connection with a polarity or adjustment toward the expression of the character.

PROBLEMS OF TRANSMISSION AND EXPRESSION.

A curiously vivid analogy between the expression of characters and the expression of ideas is worthy of note at this point. A suggestive expression often enforces the complete logical elaboration of an idea, even in the face of contradictory facts. It is commonly supposed that the phenomena of alternative expression of divergent parental characters remained entirely unconsidered in the interval between the publication of Mendel's

work in 1866 and their rediscovery by De Vries and Correns in 1900. But in 1889 Galton published his book on "Natural Inheritance" including a chapter on eye-color in the human species, in which the following statement occurs:

"Stature and Eye-colour are not only different as qualities, but they are more contrasted in hereditary behaviour than perhaps any other common qualities. Parents of different Statures usually transmit a blended heritage to their children, but parents of different Eye-colours usually transmit an alternative heritage."[1]

It is evident enough from the context that the author used these words merely to describe the facts which he had ascertained regarding differences of eye-color among members of the same families, and not with the intention of proposing a new theory of the mechanism of descent. Nevertheless, it launched an expression which could be converted readily, and even unconsciously, into a theory of alternative transmission of characters, and thus undoubtedly did much to lend popularity to the "rediscovery of the Mendelian principles." Galton appears to have had no intention of suggesting that the transmission of one character inhibits the transmission of another character. He predicated transmission only from the standpoint of the parents, and as shown in the characters of the immediate offspring, and fully understood that these offspring would be able to transmit characters which their own bodies did not express. But the Mendelian theories have discarded such reservations and distinctions, and have gone over bodily to the assumption of alternative inheritance in the most complete sense of the words. They predicate the existence of character-unit particles and of germ-cells which receive and transmit particles representing only one of a pair of contrasted parental characters. But no such method of inheritance has been proven, and no such assumptions are required, or even permitted, by the facts of Mendelism.

Inheritance has been used unconsciously in two different senses, to cover and confuse two distinct phenomena, the transmission of characters and the expression of characters.

[1] Galton, Francis, 1889. Natural Inheritance, pp. 138–139.

Regarding the real natures or details of the processes of transmission and expression, we know as little as we did of inheritance, but it is a measure of progress to learn that there are two factors instead of one. Transmission inheritance is not reciprocal or alternative like expression inheritance.

The relations which may be supposed to determine the characters of conjugate organisms are obviously very different from those which determine the characters of the gametes. The characters of a conjugate and those of the gametes it produces may both be results of relations assumed by the same original parent gametes, but the relations in the two cases are entirely distinct, as the results themselves testify. The conjugate results are large, highly complex organisms, while the exjugate results are minute, simple gametes.

The older interpretation of the facts of descent led us to reckon the gametes as products of the bodies of the plants or animals, minute propagating particles qualified to faithfully reproduce the same kind of a body, unless this were prevented by external circumstances. The present interpretation recognizes that new gametes are not so much the offspring of the conjugate body as of the gametes from which the body was formed. The gamete-producing cells are often related to the cells of the body of the "parent organism" only as they represent common offspring of the original gamete-pair, and even then there is the very serious difference that the body-cells, being devoted to vegetative purposes only, do not complete conjugation at all. The gamete cells do not correspond directly to any of the body cells because they have passed through mitapsis and belong already to a new generation, a new section of the network of descent.

Conjugate organisms are built up at the knots or junctions of the networks of descent. In the lower groups exjugate cells build up organisms on the threads of the network, between the knots. Conjugate organisms can be thought of as thickening the knots of the network, exjugate organism as thickening the threads. But in both cases vegetative specialization may bring a loss of reproductive powers and exclude the specialized cells from any direct representation in the subsequent network of

descent of the species. In neither series was there any primary or essential difference between the cells as body-cells or as germ-cells, but vegetative specialization has repeatedly, and in many independent groups, rendered a part of the cells sterile neuters whose function it is to nourish and protect the reproductive cells and the helpless offspring, instead of leaving any direct progeny of their own. Organisms are, after all, merely social organizations of cells, and there are different kinds of cell-organizations, just as there are different kinds of organizations among men and other social animals.

Generally speaking, the cells which compose the bodies of the higher organisms do not leave any descendants to perpetuate their characters. Except for the fact that the body-cells and the sex-cells are both descendants of the original gametes, there is no relation between them, just as the highly specialized castes of ants and termites are sterile, and are propagated anew in each generation from normal sexual insects, and not from any ancestors which possessed these specialized caste characters. Thus if the character-unit theory were to be logically elaborated the germ-cells would need to be thought of as containing, not merely units to represent the formal characters in which species and varieties differ, but units governing the characters and adjustments of every separate cell of the vegetative body. All the different kinds of cells which compose the body of a higher plant or animal represent as many cell castes, and there would need to be character-unit determinants to govern the formation and arrangement of these, quite as much as for the different kinds of organisms which the species may contain.

The germ-cells continue to transmit characters which can be brought into expression only through the medium of vegetative cells which do not take any part in the reproductive process, any more than soldiers, workers and nurses of a colony of ants or termites. The complexities of this problem of transmission transcend the powers of the human imagination, but there do appear to be any corresponding limitations in practice, for even characters which are not expressed may still be carried along, generation after generation. The greater the number of details the more effective and reliable is this hereditary memory, if

only it be allowed a reasonable diversity of alternatives of expression. But if too closely restricted to the monotonous repetition of the same story in each generation it wanders from the hereditary pathway, though it may be recalled to the path by reminiscent contact with another wanderer from the same group.

It is very natural to infer that the characters of conjugate organisms are contained in the germ-cells, since the organisms are known to develop from germ-cells. But as yet we do not know how the characters are contained in the germ-cells. We have no concrete knowledge whatever of the nature of characters during the interval of transmission or pre-expressional existence. But we do know that the conditions of character-expression are essentially different from those of character-transmission. Dominance and potency are *phenomena of expression*, and afford no hint or basis of inference regarding the nature of the *mechanism of transmission*.

There is no longer any reason to believe in any general or fundamental difference between somatic and germinal tissues as alleged by Weismann. The bodies of the higher plants and animals simply represent different degrees of vegetative specialization of tissues once wholly reproductive. A distinction is to be drawn, however, between the transmission of characters by simple or exjugate cells and the expression of characters by conjugate or double-celled structures. Mendelism and other forms of polar descent give us no new knowledge regarding the structure of gametes. They concern only the expression relations which these gametes assume in the conjugate condition.

Conjugate organisms are not merely resultants of the characters which the gametes were adjusted to bring into expression; they may show a reciprocal expression of the gamete polarities, or may have characters which neither of the gametes would have expressed if it had a partner of its own kind. If two magnets or magnetic compasses are brought together their directions will change, and if one overpowers the other both may take the same direction. Transmission is represented by the dial of the compass, expression by the needle. One organ-

ism can express only one set of characters, though it may transmit to posterity an unlimited number of varying equipments.[1]

Conjugate organisms may give no hint of the presence of a character which the gametes are able, nevertheless, to transmit unimpaired through long series of generations. The behavior of two gametes in the conjugate phase is no criterion of the results of the conjugation, as represented by the new gametes of the next generation. The inheritance of expression-polarities is entirely distinct from transmission-inheritance. Expression-polarities may be mutually exclusive, so that polarity of one character implies the abeyance or non-polarity of expression of alternative characters, but there are no indications of such exclusiveness in the transmission of characters.

If transmission is to be thought of as accomplished by character-unit particles the indications are that the tendency is to accumulate as great a diversity of particles as possible, instead of excluding any because of incompatibility. Transmission is inclusive, not exclusive. The continued transmission of a character can not be ascertained, of course, unless it be brought into expression, but the possibilities of transmission without expression are now amply demonstrated. To assume that a character has failed of transmission because it remains unexpressed, is entirely gratuitous.

It remains true, of course, that the characters of the gametes can only become known through their expression in conjugate organisms, but this difficulty of interpretation does not absolve us from the recognition of two distinct factors or problems of inheritance. The problem of potency relates to the polarity or adjustment of unconjugated gametes toward or away from the expression of certain characters. The problem of dominance has reference to the adjustment of gametes in the conjugate relation. We have yet to learn why the polarity of one gamete overpowers the other and completely controls the development of the conjugate body, and how the abeyant polarity of the other gamete is able to reassert itself at the period of mitapsis and secure equal representation in the new generation of gametes.

[1] Cook, O. F. Transmission Inheritance distinct from Expression Inheritance, Science, N. S., 25 : 911. 1907.

As bearing upon the solution of these problems of descent, the facts of Mendelism take on very great interest and importance. As yet they have served only to obscure the issues because they have been interpreted as phenomena of incompatibility or "disjunction." The facts of Mendelism take on far greater significance as soon as we cease to compare them to the abnormal results of incompatible hybrids, and perceive the far closer analogy with the alternative or polarized expression of sexual differences.

RELATION OF MENDELISM TO NORMAL DIVERSITY.

Only the gratuitous assumption of ideal uniformity stands in the way of a recognition of the fact that the normal tendency of evolution is not toward "identity of form and structure" inside specific lines, but toward the development of diversity among the members of species. Diversity between the members of the same species is often accentuated by differences of environment, but there are many differences, both individual and sexual which are independent of the environment, and which continue to appear, without regard to uniformity or diversity of environment. Mendelism, like sexuality, is a means of preserving a desirable diversity of descent inside the species. It is not a phenomenon of incompatibility, but rather of avidity, tending to strengthen conjugation by accentuating the unlikeness of the gametes.

Sexuality and Mendelism are both to be reckoned as phenomena of normal diversity of descent, or heterism. Sexuality is the more specialized form of heterism, because only sexually diverse gametes are united in conjugation, whereas like gametes can still conjugate in Mendelian descent, and thus miss the effect of the desirable diversity which in sex-inheritance is fully preserved. But sexuality and Mendelism are very closely alike in methods of inheritance. Each organism and each gamete represents the expression of one of a pair of contrasted characters, but not both. There is no tendency to combine the characters into an intermediate average. The series or scale of possible variations is represented by the two extremities, while the intermediate points come only rarely and abnormally into expression.

As Mendelism may be considered a somewhat weaker form of sex-inheritance, so there are weak forms of Mendelism which serve to connect the definitely polarized forms of alternative descent with the other still less specialized methods of inheritance. Instead of the typical dominance of one parental character in the conjugate phase, there may be an intermediate or compromise, but this need not interfere with alternative descent in the gametes of the next generation. Or it may happen that the conjugate organism expresses a character shown by neither of the gametes when mated with their own kind. Definite alternative descent in the gamete progeny also grades off into intermediate expressions of the two characters, or into the expression of a whole series of integraded intermediates, or some ancestral characteristic may reappear, though long dormant in both the parent varieties.

The extent to which Mendelism and other less accentuated forms of polarized inheritance exist in natural species is a subject which has received very little investigation thus far. The reasonable expectation would be that species will be found to differ very greatly in these respects, just as they show very great diversity of degrees of accentuation of alternative sexual characters. Narrow breeding, which tends to the accentuation of variations, probably tends also to the accentuation of polarity of expression. This agrees with the fact that Mendelism is so frequent a phenomenon in crosses of narrow-bred varieties, but so rare in crosses of undomesticated species or subspecies. A course of narrow breeding, such as experimenters in Mendelism prescribe as a means of ascertaining the "purity" of the stock by securing uniformity might well bring the plants or animals into condition for an exhibition of strict Mendelism, instead of showing somewhat less specialized forms of polar inheritance. Mutative variations which represent reactions from abnormal uniformity may be ready from the first to make the most of the new diversity by means of polar inheritance. Nor is it without significance for general evolutionary purposes that the natural selections of a dominant variation would not tend toward uniformity, but preserve and increase the heterism of the species. It is only by highly conscious selection of the "pure domi-

nants" that we can avoid the natural result of perpetual hybrid diversity.

EVOLUTIONARY IMPLICATIONS OF MENDELISM.

The general evolutionary significance of Mendelism as a method of descent does not lie in the assumptions of character-units and pure germ-cells, but in the facts of polarized inheritance, which show how new variations may be preserved without isolation and become the means of evolutionary progress of species. There are, as we have seen, all degrees of accentuation of the phenomena of dominance and polarity. The narrow-bred varieties and mutations show them in the most extreme form, but sex-inheritance is very widespread, and the other less accentuated forms of specialized diversity will probably be found to be quite as generally distributed.

Hitherto we have been expecting species to be uniform, and have considered the presence of definite diversities in the same species as something exceptional and peculiar. The possibility that new variations may be preserved without isolation and thus contribute to the evolutionary progress of species, was recognized some months ago by Professor Davenport,[1] but was then associated with the mutation theory of De Vries, with which it has no true relation. Professor De Vries is particularly explicit in denying any such process of gradual transformation, his theory being that the fact of mutation by itself constitutes the evolution of a new species, which remains unchanged until another period of mutation ensues.

"There is neither a gradual modification nor a common change of all the individuals. On the contrary, the main group remains wholly unaffected by the production of new species. After eighteen years it is absolutely the same as at the beginning, and even the same as is found elsewhere in localities where no mutability has been observed. It neither disappears nor dies out, nor is it ever diminished or changed in the slightest degree. . . .

[1] "Such facts as I have cited above [melanic sports, etc.] . . . seem to lead me to the conclusion that some new characters may arise in nature suddenly . . . and persist as specific characteristics. The Mutation Theory in Animal Evolution, Science, N. S., 24: 558.

"Thence we must conclude that new species are produced sideways by other forms, and that this change only affects the product, and not the producer."[1]

But if a new variation can arise suddenly and persist without isolation as a character of its species, the producer is changed as well as the product. Indeed, the new variation does not gain or maintain its existence as a separate product, but merely increases the diversity of the parent group.

Spontaneous transformation of species by the prepotency of new variations, under natural conditions of wide distribution and free interbreeding, is the method of developmental progress outlined in what has been called the kinetic theory of evolution. Previous theories had not recognized the possibilities of direct and spontaneous accumulation of new variations. Usually they had sought the agencies of evolution in the isolation of variations by selection or in other forms of environmental interference with an ideal condition of uniformity and stability. The mutation theory of De Vries reasserts this uniformity and stability as the moral condition of species, and seeks to explain evolutionary progress by sudden leaps from one species into another, and not by any gradual change, through prepotency

[2] De Vries, H., 1905. The Evidence of Evolution. Smithsonian Report for 1904, p. 396.

An even more detailed and explicit denial of any gradual transformation of species is contained in a paper by Professor De Vries in the Monist for January, 1907.

"The conception of mutations agrees with the old view of the constancy of species. This theory assumes that each species has its birth, its life-time and its death even as an individual, and that throughout its life it remains one and the same. Thus it is only natural that wild species are almost always observed to be constant, since by a mutation they do not change themselves but simply produce a new type. This is allied to its ancestor as a branch is to a tree, the stem continuing its own growth, no matter how many branches it produces. Just so a species may produce quite a number of new forms without being changed itself in the least thereby. Among palæontologists Scott has given forth this same view. According to his conception, species are derived from one another by small shocks. Each shock caused the old limits to be transgressed; but, after it, the new species remained unchanged until, perhaps after centuries, a new shock made it transgress its new limits. Each single type (be it species, subspecies or variety) is thus wholly constant from its first appearance and until the time it disappears, either after, or without, the production of daughter-species."

or otherwise. The degenerate nature of mutative variations of narrow-bred groups and the fact that they usually fade out entirely when brought into contact with the unrestricted descent of the wild type, are further practical reasons for the complete divergence between the mutation theory and that of kinetic prepotency. But even mutations are usually prepotent among their own equally narrow-bred relatives, and thus afford at least an illustration of the power of genetic variations to maintain themselves and gradually transform broad-bred species in nature.

Instead of compelling us to abandon the conception of evolution as a process of gradual change in the characters of a species, mutations and Mendelism in reality strengthen and reinforce this older idea of continuity. They show that progress does not depend upon environmental causes, either direct or indirect. The studies of mutations have made it certain that diverse variations occur, even under the same condition, and Mendelism demonstrates that such variations can also be preserved without isolation. Both Mendelism and mutation, in their typical forms, represent abnormal conditions of restricted descent, but they may still have great evolutionary interest if we accept them as evidence, or even as suggestions, that less accentuated forms of the same phenomena of inheritance are concealed among the more nearly indiscriminate diversities shown by the members of wild species in nature.

Evolution is a process of change in the characters of species, and not merely the origination of new species, either by mutative leaps or by Mendelian combinations of characters. Evolution is accomplished by the gradual, constructive synthesis of variations. Darwin may have been in error in supposing that evolution is actuated by selective agencies of the environment, or that the steps by which it is accomplished are infinitesimally gradual, but it has yet to be shown that he was in error regarding the general continuity of the motion as indicated by the continuity of the differences inside the species and also of the species themselves when viewed as members of genera, or of genera when grouped in families.

This fact of continuity convinced Darwin of evolution, and not natural selection and other theories by which he attempted

to explain evolution. It is not too much to say that all who have faced this question in the light of broad and thorough knowledge of species in nature, agree with Darwin regarding the generally continuous and the gradual character of evolution, no matter how much they may differ with him regarding methods and causes. It is at this point that taxonomic studies have a very practical bearing on evolution, and become an almost indispensable training and qualification for evolutionary judgment. The difference between mutations and natural species is not that they are less different than species, as Professor De Vries and his followers had feared, but that they are more different than species, and different in a different way. They lack the indiscriminate diversity, the protean flexibility of form which often renders it extremely difficult to find any completely diagnostic differences between species which are nevertheless truly distinct in nature. Mutations of the same species, on the contrary, commonly differ in numerous, definite and much more constant characteristics. The two phenomena, species and mutations, belong to essentially distinct categories, as unlike as crowds and drill-corps.

Mutation is not a period, but a condition. A narrow-bred group in the mutative condition all wears, as it were, the same uniform. A new mutation constitutes a definite change in this uniform. It would be very much easier to describe and classify the military uniforms of the various European nations than to find any equally diagnostic characters for the nations themselves. The nations are much more seriously and essentially different, of course, than their military uniforms, but the differences are of a different sort, and not to be stated in the same terms. Species have more essential evolutionary differences than mutations, though mutations are at the same time more definitely different. The phenomena are, in short, of different categories and incommensurable. Discussions can lead to no conclusions until these fundamental diversities of facts and concepts are appreciated.

Professor Davenport has assured us that "The question of the origin of species is that of the origin of specific characteristics or differential marks." But, unfortunately, there is no evo-

lutionary connection between the origination of species and the origination of marks or characters by which species may, or may not, be distinguished. Species may be quite distinct and may yet offer precious few diagnostic marks. On the other hand, one and the same species may manifest so much diversity of characters that numerous species could be distinguished were it not for the intergrading forms.

Though many have taken it for granted, nobody has shown that there is any relation between the origination of characters and the origination of species. Species do not have to be originated to originate characters, nor characters to originate species. Nor has it ever been shown that the origination of species has any causal relation to evolution. Species originate by isolation, that is, by the subdivision of older species. The groups attain differential characters after isolation, in the same way that characters would have continued to be attained if the original species had not been subdivided. The origination of the species does not cause the origination of characters, nor does the origination of characters cause the origination of species.

Nor is there any necessary relation between the discontinuity of characters which distinguish species and the discontinuity of character-diversity among the members of the same species. Species might differentiate in the most gradual manner, but having once differentiated their characters would be discontinuous, for this is the taxonomic criterion of specific differentiation. Nevertheless, discontinuous variations might spread gradually through a species and transform it. The discontinuity of the variations would not break the continuity of the evolution of the species. Discontinuous variations make the mutation theory abstractly conceivable, but they do not afford any evidence that it is the true method of evolution.

The origin of species is not evolution; evolution is the changing of characters in species. Not all changes of characters are evolution, but only changes of characters in species, or changes of the same nature as changes in species. Mutative changes of characters in narrow-bred domesticated varieties, and the strict Mendelian polarity of expression of such mutative differences, are not phenomena of evolution, but of degenera-

tion. They do not teach us the principles or methods of normal constructive evolution, except as we learn to interpret them conversely. The discontinuity of variation shown by the origination of these characters of degenerating domesticated varieties finds few complete parallels in nature. Moreover, these mutative characters, instead of being nicely preserved in nature, are wiped out by contact with the wild stock of the species, or even by free interbreeding among the domesticated varieties themselves. The prepotency of recent mutations corresponds to the prepotency of genetic variations in nature, but the evolutionary status of the mutations is very different from that of the genetic variations.

Discontinuous variations do not prove discontinuous evolution, but makes continuous evolution more practicable and probable. It is true that Darwin and many other believers in selection as the motive power of evolution have dwelt upon the efficacy of accumulating even infinitesimal differences, but there can be no objection to the accumulation of variations of more than infinitesimal size if the facts seem to justify such a view. The fundamental issue is between evolution, or gradual changes in species (whether by smaller or larger steps), and saltation, or sudden jumps from one species into another. De Vries has even been careful to specify that the jumps shall be sideways, on the ground that species once originated by mutations do not change or make further advances, all progress being confined to lateral displacements of mutative variation.

Mutations and Mendelism are very interesting phenomena, not only for breeders of domestic plants and animals, who have long known them under other names, but in adding, if somewhat indirectly, to the evidence that new variations are prepotent, and that evolution may be accomplished by the spontaneous accumulation of appreciable genetic variations, instead of depending upon the selective integration of infinitesimal effects of environmental influences. When this distinction between discontinuous variation and discontinuous evolution is once appreciated, it will become apparent that the mutation theory and the Mendelian "laws" which have been enlisted in its support are assumptions which the facts do not warrant.

But no cause is lost without contributing something to the progress of science.

The attempted resuscitation of the saltatory theory and the Mendelian "laws" has resulted in a new and more thorough survey of this part of the field of variation, the same ground which had been canvassed by Darwin's contemporaries and critics, Mivart and Galton. But the general implications of the facts do not appear to be very seriously altered. Darwin considered the possibilities of saltatory evolution, but dismissed the idea as of incidental significance only. Galton estimated the value of discontinuous variation much higher than Darwin, but was not misled into the hazardous conjecture that saltatory variations cause evolution by originating new species.

Darwin did not imagine that he had solved the problem of evolution in the sense of having definitely ascertained the nature of the motion or the causes of the variations by which it goes forward. He was solicitous rather to make the doctrine appear sufficiently reasonable to secure the serious attention of the scientific world. He did not have complete confidence in the foundations of his own colossal idea, and labored hard on natural selection and other unnecessary scaffolding to support it. Later criticism is removing these superfluous theoretical timbers, but the primary conception of evolution as a process of gradual change in the characters of species, not only remains intact, but stands forth with increased assurance of truth and permanence.

CONCLUSIONS.

A typical experiment in Mendelism, instead of involving two successive crosses or conjugations of gametes, includes only one such cross. The so-called first generation is built up by the vegetative subdivisions of the gamete parents, before conjugation is completed. The so-called second generation represents the first organisms produced after the completion of the conjugation of the gamete parents.

The difference of proportion between the two generations in the expression of divergent parental characters is to be explained by the peculiar methods of reproduction followed by the higher plants and animals, and by the fact of dominance or expression-

polarity, instead of by the Mendelian theory of alternative inheritance of character-unit particles.

Mutations do not differ from Mendelian hybrids in any essential respect, either at the time of their first appearance or in later combinations. The preservation of the new character by definitely reciprocal inheritance of expression-polarities is favored by the same conditions of restricted descent which induce the mutative variations.

The analogy of the Mendelian phenomena, applied to variations induced by crossing, shows that new characters which come to expression in the first or conjugate generation are not likely to be permanent. Dominant variations can gain expression in the second or perjugate generation, but recessive variations are not shown before the third generation, and may not be brought into expression until still later generations, unless the first perjugate generation is self-fertilized. As many variations of economic value behave as recessives, this fact is of practical significance in breeding experiments.

Two distinct phenomena have been confused in the Mendelian conception of inheritance, transmission and expression. The failure of a character to secure expression does not indicate that it has failed of transmission. Polarity, or reciprocal expression inheritance of divergent parental characters, explains the phenomena of Mendelism and related forms of descent without requiring the assumption of pure germ-cells or of character-unit particles.

There is no evidence that normal transmission-inheritance is a phenomenon involving the alternative admission or exclusion of character-units, or that characters are transmitted as particles or mechanisms. The process of transmission is independent and separate from the process of expression, which often yields polar or reciprocal results. This reciprocal polarity of expression-inheritance shows how new characters can be preserved and thus contribute to the normal diversity of a species or gradually transform it. Evolutionary advance can thus take place without selective or geographical isolation. The general evolutionary significance of Mendelism lies in its testimony to this fact, and not in the theories of inheritance by character-units and pure germ-cells.

The accumulation of variations without isolation agrees with the other evidences of evolution by the continuity and gradual transformation of the characters of species. It shows that the phenomena of mutations and of Mendelism do not justify the theory of saltatory or discontinuous transformation by leaps from one species into another. The latter assumption requires the formation of a new species to preserve each new character, while the former permits simultaneous progress in the constructive combinations of many characters inside the network of descent of a single, undivided species.

PROCEEDINGS

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. IX, PP. 241–274. JULY 31, 1907.

LINNÆAN MEMORIAL ADDRESS.[1]

By EDWARD L. GREENE.

INTRODUCTORY.

THE personality of Linnæus, and his luminous career as a scientific man, make a topic much too large to be presented even in mere outline within the limits of an hour. If this were an assemblage of botanists exclusively, still would the time be too short for the worthy consideration, not only of Linnæus as a botanist in general, but of his services to any one only of the several departments of the science which it is his glory greatly to have advanced. But then, a botanist, a very great botanist, he was also much more than that. I have a fancy — it may be more and deeper than a fancy — that a great man in whatsoever profession, a man of power in any branch of science, is greater than the science to which he devotes himself; that he himself personally is of more moment, and ought to be of deeper interest than his science; yes, than all the sciences that are or ever shall be.

If we could in thought divest Linnæus of his systematic botany and zoology, we should still find ourselves in the presence of a man of the highest educational accomplishments and general culture, clear-headed and original as a thinker, a philosopher, religionist, ethnologist, evolutionist, traveller, geographer and a most able and polished man of letters. There are so

[1] Delivered at a joint meeting of the Washington Academy of Sciences, the Biological Society of Washington and the Botanical Society of Washington, held at Hubbard Memorial Hall, on the occasion of the two-hundredth anniversary of the birth of Charles Linné (Carolus Linnæus), May 23, 1907.

many more aspects of a great character, the presentation of which, one by one in a discourse, might interestedly engage the attention of others besides nature students.

Confronted by so very much that may be said, and which it might seem ought to be said on this day dedicated to Linnæus, and, checked by the consideration that only a few selections from out the whole mass may at this hour be taken, where shall one begin? Whither shall one proceed? What thrilling passages in a career so almost marvelous shall be left unnoted for want of time, and of what few of them shall the rehearsal be attempted? Or, reducing these questions down to two: Shall the *man* be presented with citation of his struggles with adverse circumstance, and of the almost incredible patience, industry, zeal and resolution with which he conquered and rose to high renown? Or shall one consider rather the *work* of the great master of botanical theory and taxonomic abstraction? There will not now be time for both; not even though attempted in mere outline. My own inclinations favor choice of the latter, especially for to-day; yet circumstances indicate that such a choice would here be also inopportune. Our Washington botanists at this season of the year are mostly far afield, in the service of the government. Only a fair delegation of my colleagues in this science is here present; and this enlightened audience as a body I am persuaded would much rather hear something more about the *man* of whom all the world of education and of culture has heard more or less. Even on my own part I have already expressed the view that the *man* should first be known, that we may the better comprehend his deeds.

LINEAGE AND CHILDHOOD OF LINNÆUS.

When Linnæus, on the twenty-third of May, two hundred years ago was born, I think it had long been predetermined that he should be a botanist, and one of high distinction. When I say predetermined, I do not use the word in any sense of theological predestination, or of astrological forecast. I have but the recognized principles of natural heredity in mind. And, unless I err, there was more inherited by Linnæus than his biographers seem to have guessed. They all repeat it that the father, the Reverend Nils Linnæus, a Swedish country

clergyman, was fond of plants, and had a choice garden wherein he took his daily pastime; and that in this garden his first-born child developed those predilections which at length became the despair of the father, yet led the son eventually far up the heights of fame. All this is authentic, and well told by the several biographers; but there is more in that history which, to me seems well worth telling, and will give light upon the derivation of Linnæus's genius as a botanist; and upon his accomplishments as a man of learning and of letters. Let us go back to the second generation of his ancestry and glance at men, women and social conditions.

The grandfather of Linnæus, on his father's side, was a Swedish peasant, by name Ingemar Bengtson. His wife had two brothers who became university graduates, were afterwards clergymen of some distinction, and men of reputation in the world of learning. These grand uncles of our Linnæus interest us because of their having figured somewhat conspicuously as stars of destiny in relation to him long before his birth. They even had somewhat to do with the originating of the family name Linnæus. But for their influence in this direction it is probable that their grand nephew, then unborn, if he had distinguished himself as he did, would have been known in history and to fame not as Carolus Linnæus, but as Karl Nilsson. That both these grand uncles of Linnæus were Greek scholars seems attested by the fact that, in assuming a new family name, after the mediæval usage of those who arose from the humble estate of peasantry to the aristocracy of learning, they choose the Greek name Tiliander. They were Karl and Sven Tiliander. In their boyhood they had been known simply as Karl and Sven Svenson, and if they had remained uneducated, and in the same lowly and simple estate in which they were born, they would have been known by those names to the end of their lives. Karl Tiliander rose to wealth and station, adopted a coat of arms, in a word, was an aristocrat, but died childless. His grand nephew, however, born ten years after his death, was named in his honor. In fact, Karl Tiliander and Karl Linnæus are, in meaning, the same name precisely. Now the other great uncle, Sven Tiliander, was a minister, had a family of minister's sons

to educate, and was generons enough to receive as one of his own sons his sister's son Nils, to be educated with them. This peasant boy Nils Ingemarsson, remember, is the predestined father of our Linnæus. But this boy's-school scene, lying away back almost upon the edge of mediæval times, and afar in the north of Europe, well towards the country of the midnight sun, is a pleasant scene, before which we must pause a moment. It is in midst of a time when great people may lead simple lives, and when a family group of boys, destined if possible to the intellectual life—and at least to one of the learned professions, are not at first to be sent away from home. They live under the parental roof, and their Latin tutor lives there with them. That is the language in which, later at college and at university, lectures on all subjects will be given; it will be the language in which most of the books there used are printed; the language of recitation and of student debate.

So these small boys at home begin Latin. They also so begin it as if they were to become interested in it, and really to learn the language, and not to end with a mere smattering of it. They are to speak it, as well as read and write it. Therefore it becomes at once, in as far as possible, the medium of spoken intercourse between tutor and pupils; the father of the family himself incidentally aiding the tutor, by addressing the youngsters at meal time or recreation in Latin, and requiring them to answer in that, and not in the mother tongue. It was a serious business; the entrance to college, the matriculation at any university, the rising to any learned profession even, are dependent upon the boys having made good progress in the acquisition of this, at that time the universal language of the educated. The Swede or Finlander even, if a college man, might visit every country of Europe, and converse with the men of the colleges and universities everywhere, without learning one of the modern languages. Linnæus even, two generations this side of the epoch of his great uncles the Tilianders, did this. Now, among this aristocratic caste of the learned, in mediæval times and later, it was almost the universal custom with men of lowly origin, to drop the ancestral family name, and assume a Latin one. It was a fashion of the time; and, as I have said,

the time lasted through many centuries. When Latin was the language of a certain social caste, and the language of almost all authorship, the canons of good taste seemed to require that the author of a book in Latin, should put his name in Latin on the title page; and not in some barbaric Teutonian or Russian or Scandinavian or English form to which, as to a plebeian inheritance, he might chance to have been born. Such is the origin of the general circumstance, familiar to all botanists, that nearly all the thousands of volumes of botanical literature that antedate the beginning of the nineteenth century, are by authors whose names are plainly Latin names. The same is true of the earlier literature of all our sciences. It was all in Latin; and the author's names are Latin names.

The greatest name in astronomy, but for the man's Latinization of it on the title page of his immortal book, would have come down to posterity as Kupernik. But all astronomers, and all other people besides should be grateful that, the book being in Latin, he wrote himself not Kupernik but Copernicus. The most illustrious of old-time Chinese sages was and is known to his countrymen as Kung-fu-tsee; but the Latin scholars who, some centuries ago, first brought him to the notice of the western world, wisely and tastefully Latinized Kung-fu-tsee to Confucius. A single generation earlier than Linnæus there flourished in Germany one of the greatest botanical celebrities which that country has produced. His splendid folios are now so rare that only the choicest botanical libraries of today are able to catalogue a set of them; and they were very helpful to the young Linnæus. This famous German, as a boy, and before his college days, rejoiced in the plain everyday Teutonian name of August Bachman. Afterwards as professor of botany at Leipzig, and the author of immortal books of botany in Latin, he assumed the most perfect counterfeit of an ancient classic Latin personal name which I can recall. This August Bachman is known in history and to fame as Augustus Quirinus Rivinus. The name Rivinus was arrived at in the simplest kind of a way; for it is nothing but Bachman — the man who dwells by a rivulet or brook — translated into Latin. Now just as Rivinus —in German Bachman — recalls a stream-bank where the Bach-

man family lived, so those forebears of Linnæus who, on rising to the rank of gentry, took the Græco-Latin name Tiliander, chose that improved appellation in allusion to an object in the landscape near their home. That object was a remarkably large and ancient linden tree; a tree of special note all over that part of the country. Tiliander, — Lind-tree-man; or more in brief, Linnman. In Swedish it would be Lindman. So these two learned brothers who became the head of the Swedish family of the Tilianders, chose a botanical name; incidentally presaging the botanical halo that was to glorify a future cion of their stock under the same name somewhat altered. Now if the name Tiliander was prophetic incidentally, it had not been chosen accidentally.

The Reverend Sven Tiliander, uncle and foster father of the father of Linnæus, was a devoted lover of trees and plants. It was that passion for botany which determined his taking the new and classic-sounding family name from the great linden tree. At the time of his taking his nephew Nils Ingemarsson into his family to make of him if possible a scholar and a Lutheran priest, he had extensive orchards and gardens to the care and improvement of which he was enthusiastically devoted. This enthusiasm for such things became contagious in the case of his nephew Nils, insomuch that the boy found delight in going with his uncle and helping him in orchard and garden. Twenty years or so afterwards, when this nephew, now a learned graduate and assistant minister of a parish, as the Reverned Nils Linnæus — no longer Nils Ingemarsson — he was so deeply imbued with the love of the beautiful things of the plant world, that he began the establishment of orchard and gardens on the parish farm when his residence was established. A word here as to his new name Linnæus, which had now displaced that peasant's name Ingemarsson to which he had been born. Reared and educated along with his first cousins the Tiliander boys, it may be assumed the whole family may have thought it better that, as scholar and gentleman, he should take some other name than Tiliander. At all events, and quite as if in grateful love of his uncle and cousins, he took a name precisely the equivalent of theirs — the name of Linnæus. It is

not quite as elegant in its construction as Tiliander, but its meaning is just the same. It is another way of turning Lindman into Latin. And so Nils Ingemarsson, by changing his name to Linnæus, paid high compliment to that uncle and benefactor, Sven Tiliander, to whom he owed so very much, commemorated again that ornament of the northern landscape, the great linden tree, and supplied to all scientific posterity the illustrious and immortal name Linnæus. In view of this, that the most signal and lasting service that the greatest Linnæus rendered botany was the reform he wrought in the Latin nomenclature of plants, the derivation of his own name, its botanical origin and character, can not fail to be of interest to all who, on this his two-hundredth natal day, unite in celebrating his imperishable fame.

The Reverend Nils Linnæus, was no sooner married and settled in the charge of a parish than he began the creation of an orchard and garden; following the inspiration he had received in boyhood while under the benign influence of his uncle, the Reverend Sven Tiliander. When Nils Linnæus's garden had been four or five years established, the proprietor began to lead within its precincts his first-born child, a small white-haired boy, active and intelligent beyond the average, for his years. Flowers, beyond all things else, were this small child's delight. Even at the age of four years he knew the names of all the familiar kinds. On a May day picnic excursion that the pastor gave the children of the parish, to a wild and beautiful spot some few miles away, this botanical nomenclator that he was to be, nearly monopolized the pastor's time with questions of plant names. Many kinds, to him until now unknown, and therefore nameless, he must have names for. Some of them were forgotten within an hour, and were brought again. The father's patience gave way a little, and the threat was made that unless Master Karl Linnæus was more careful to remember them he would get no more plant names at all. If the Reverend Nils Linnæus had thought it time to begin to check his child's extraordinary zeal for plant knowledge, this was the wrong way to go about it. That threat, though a mild one, would be sure to have the opposite effect. If the infant had in-

herited the father's temperament, the matter would have been unimportant. I may rather say that, if the child Linnæus had been of the father's temperament, this restless activity and burning zeal, whether for plants or for anything else under the sun, would not have been there, and that small white-haired Scandinavian child's birthday would not have been celebrated on two or three continents, after two hundred years.

If a paradox like this may be ventured, one may say that the fatherhood of a great man must, in many an instance, be credited to the mother. The man of power and influence may have for his male parent one of quiet retiring manner, unaggressive, unambitious, and even slow, if the mother be very decidedly of the opposite temperament, active, energetic, ambitious, ardent, and also young, strong, and in perfect health. Just these conditions prevailed at the nativity of Linnæus. The strong character in that household was the mother, Christina Broderson Linnæus. It is safe to infer from her antecedents that she was a woman of refinement and perhaps unusual mentality. She may almost be said to have had none but cultured men among her ancestry for three generations back. We have already seen that her husband was her father's successor in the Stenbrohult pastorate. Her father had not only been pastor there all his official life; he had been born there, as the son of the pastor whom he in turn succeeded; so that her father and her grandfather had been pastors of that parish all their lives — so to speak — while the priest who preceded her paternal grandfather in that same church had been her great-grandfather on her mother's side. Realizing now that, when in the nineteenth year of her own age Christina Linnæus's first-born arrived at the parsonage where both she and her father before her had been born, where a grandfather of hers and even a great-grandfather had held life-long pastorates, we pardon the ambition of the young mother who set her whole heart and soul upon the plan of having this her first-born trained and fitted to inherit that pastorate already historically so remarkable; of which history she could not but be proud.

SCHOOL, COLLEGE AND UNIVERSITY YEARS.

The mental training of the child Linnæus was, of course, begun at home. At seven years of age he was well enough advanced to have a tutor. At ten he was sent away to a Latin school and theological preparatory at Wexiö, not many miles from home. After eight years there, the progress made in studies looking to the office of a Lutheran ecclesiastic seems not to have been satisfactory; and now the Reverend Nils Linnæus came journeying to Wexiö. The instructors whose duty it had been to train the boy in Hebrew and biblical learning had failed to interest him; and they said to the father that they could not, on their consciences, advise him to continue the youth at school. In their view it would be better at once to apprentice him to the learning of some handicraft; that of carpenter, or tailor, for example. Doubtless this counsel would have been followed, but that Pastor Linnæus had another errand at Wexiö that must be attended to before the disheartened return to Stenbrohult, whither, as it now seemed, he would have to convey his son now eighteen years old, as withdrawn from college because of his having no taste for learning; that is, theological.

Pastor Linnæus's other errand was that of placing himself under the direction of an eminent physician of Wexiö as to an ailment of his. The physician was Dr. Rothman, who was also a lecturer on medicine at the college; and this man, as it happened, both knew and was much interested in the youthful member of the Linnæus family. When the father confidingly mentioned his deep grief over his son's failure at school, Dr. Rothman was able to cheer him with a very different account of his boy's proficiency. He was so confident that, out of this bright youth a great physician might be made, that he proposed to receive him, with the father's consent, into his own house for a year, and give him special instruction, free of all charge; and this was done.

Now, while making himself the despair of his tutors in Hebrew and theology, what had the young Linnæus been accomplishing all these years? The idler which these thought him, he had not been. In mathematics and physics he was quite distin-

guished; moreover, his student comrades called him always the little botanist; thus by chance conveying the information that, as a youth of eighteen years, Linnæus was small of stature, and as much as possible given to botanizing. He has told us himself that, during all his years at Wexiö, the red-letter days were those of his occasional walks across the country 30 miles to the home at Stenbrohult, which gave opportunity to study the wild plants of the waysides. He had also acquired certain books on botany — Swedish local floras — in the study of which he had busied himself day and night until he almost knew them by heart, as he assures us. The titles of at least three of those books, and especially their authors' names, must needs be given on a Linnæn bicentenary that is celebrated in America. The fitness of this mention you shall see. One of the books was Rudbeck's *Hortus Upsalicnsis* (1658); another was Tillandsius' *Flora Aboensis* (1673); the third Bromelius' *Chloris Gothica* (1694). It was to the grateful memory of these Scandinavian botanists, Rudbeckius, Tillandsius and Bromelius, all of them dead before Linnæus was born, that he, in the days of his own fame, consecrated those fine American genera, *Rudbeckia*, *Tillandsia* and *Bromelia*. These men, by their books, had been his teachers of botany while he dwelt at Wexiö between the eleventh year of his age and the nineteenth. It is true that the works of these men were not of the nature of what would now be called scientific botany; that is, the plants discussed were not arranged according to any notion of their affinities. The order followed was either that of the alphabetic order of their names, as in a common dictionary, or else, if they were grouped at all, the grouping was according to their medicinal properties or other economic uses. All these books, so much beloved and revered by the youthful Linnæus, had been published before Tournefort, who, practically, and at least for the time immediately antecedent to Linnæus, was the father of natural system in botany.

It was as an inmate of Dr. Rothman's household, and while preparing under his direction to enter some university as a candidate for the doctorate in medicine, that a new day dawned upon Linnæus's horizon in respect to his botanical recreations and pursuits. The botanical system of Tournefort had now

been before the public for some thirty years. His work was the most complete and signal success that ever had been, and I may almost say, that ever yet has been, in the field of botanical authorship; because it seems to have captivated the whole botanical world, without arousing a jealous enemy, or eliciting a line of adverse criticism for twenty years; save only a mild protest from the gentle John Ray in England who, clearly superior to Tournefort as a botanist, never measured half the latter's success as an immediate and popular influence. Viewed without bias or prejudice, and in the perspective of two centuries, Tournefort's Institutes becomes the most conspicuous landmark in the whole history of botany. By no other one author's help did the science make a stride in advance equal to that made under Tournefort's influence between the years 1694 and 1730. It is important that these things be taken note of here. On the day when Linnæus was born two hundred years ago, Tournefort's dazzling star was high on the botanical horizon. It was at its meridian when, at eighteen years of age Linnæus fell under the benign influence of Dr. Rothman at Wexiö. This man made no pretensions to botany, beyond what any first-class practicing physician of that period had to know; but he had full knowledge of the great fame of the Parisian, Tournefort, and had in his library the German Professor Valentini's [1] abridgment of Tournefort's Elements. Dr. Rothman had evidently studied Tournefort and been fascinated with his system. Linnæus the youth, away in the distant north, the pupil of none but theologians, had not so much as heard of Tournefort. Rothman told him frankly that all his recreations with plants were little better than wasted time unless he should begin to recognize them as interrelated by characters of their flowers, as Tournefort had taught.

From the day when Dr. Rothman placed in his hands Valentini's key to the twenty-two Tournefortian classes of plants, the young Linnæus bent his energies in botany to ascertaining by their organographic marks to what one of the classes of Tournefort each plant that he found belonged. It was a day that com-

[1] VALENTINI (Michael Bernhard), professor in Giessen. Tournefortius Contractus, Frankfurt am Main. 1715, folio, 48 p., 4 tab.

pletely and most happily revolutionized this brilliant youth's conception of the plant world, as well as his method of investigating it. It was, in fact, the day when Linnæus, according to his own testimony about it, first began to be a botanist; and thenceforward the illustrious Parisian had never a more zealous disciple, until after some years the ardent disciple began, and in some respects deservingly, to supersede the master. It is hardly to the praise of Linnæus that in after life, when at the height of his own resplendent fame he was dedicating a genus of plants to each of his chief benefactors of earlier days, he forgot good Dr. Rothman. This man had been the first, and perhaps the most important of them all, even from the view-point of botanical training. It was certainly he who, as far as one can see, saved the boy Linnæus from oblivion when his own father had resolved to apprentice him to a cabinet-maker or a tailor. It was he who, having assumed as it were sponsorship for Linnæus as candidate for a career in science, placed in his hands the first book of real botany that the youth had ever seen, and taught how to begin to be a botanist; introduced him to the illustrious Tournefort, who at once became the lode star of Linnæus's own genius for years to come. Yet to the end of Linnæus's days there was no genus *Rothmania*. Professor Thunberg, once a pupil of Linnæus at Upsala, and long afterwards a successor of his in the chair of botany there, made tardy reparation to the neglected memory of Dr. Rothman, after both benefactor and beneficiary were dead.

After one year under Dr. Rothman's patronage and instruction, it was thought advisable that Linnæus should enter the university at Lund. In connection with the transfer from Wexiö to Lund there was an illustration of how, in the extremities of their need, fortune favors at every turn, the men of genius and of high destiny. It was requisite that the candidate should carry a formal letter of transfer from the head master of Wexiö Academy to the rector of the University at Lund. The head of the Wexiö school, a professor of divinity, must have been the selfsame who, one year before, had counseled Nils Linnæus to abandon all hope of Karl's ever becoming a clergyman, to take him home, and apprentice him to the learning of some use-

ful handicraft. To this man young Linnæus had to make application for the necessary credentials. As a matter of routine duty, the letter was indited promptly, and handed to the applicant. It was brief, and rhetorical; and, whether by chance, or of deliberate purpose, the figure of speech employed was botanical. "Boys at school," he writes, "may be likened to young trees in orchard nurseries; where it will sometimes happen that here and there among the sapling trees are such as make little growth, or even appear like wild seedlings, giving no promise; but which when afterwards transplanted to the orchard, make a start, branch out freely, and at last yield satisfactory fruit."

On reaching Lund, Linnæus first of all paid his respects to Professor Gabriel Hoek, who some years before had been an esteemed tutor of his in the earlier days at Wexiö. This gentleman was so much pleased at seeing young Linnæus there as a postulant for admission to the university, that he at once, and in complete ignorance of that humiliating letter, proposed to himself the pleasure of introducing in person, his former pupil to the rector Magnificus and also to the dean, and asking that he be registered as his own former pupil. This done, good Professor Gabriel Hoek, like a veritable angel guardian and helper, and knowing the indigence of Linnæus, went further and procured for him free lodgings under the hospitable roof of one Doctor Kilian Stobæus.

Doctor Stobæus, at the time only a practicing physician to the nobility and gentry at Lund and the regions round about — though afterwards one of the head professors at the university — at first saw in young Linnæus nothing but an indigent student with the profession of medicine in view, his only possessions seeming to be a few books of medicine. But the student, on the other hand, found the Stobæus domicile a wonderful and fascinating place. There was a library, evidently precious, because it was kept locked. There were, however, open to any one's inspection, a number of cabinets of natural history; collections of minerals, shells, birds, and — what Linnæus, though he was now twenty years old, had never before seen — an herbarium; a collection of pressed and dried botanical specimens. On this suggestion Linnæus at once began making an

herbarium of his own: its contents being the plants of Lund and its vicinity. But what he wished for beyond anything else was access to the library, though he did not dare ask for the privilege. There he would be sure to find the works of Tournefort, original and unabridged, and even older and rarer standards of the best botany. The privilege came, at last, and in a remarkable manner; by a chain of circumstances that demonstrates the young Linnæus's irrepressible zeal and most unexampled industry in acquiring knowledge of botany.

Doctor Stobæus, the owner of the first museum of natural history that Linnæus had beheld was, by Linnæus's account of him, not only of great learning and of surpassing skill in the healing art, but also himself a feeble sickly man, having but one eye, being also crippled in one foot, and a gloomy hypochondriac. A student or two in his household was a necessity. Much of his medical practice was by correspondence; and on some of the professional visits, the student must be sent. At the time of Linnæus's coming, a medical student from Germany had long been Dr. Stobæus's main dependence for help; was thoroughly trusted, and, his right-hand man. This older student the magnetic young Linnæus in an innocent way, and half unconsciously, appears to have at first captivated and then bribed into helping him in respect to that which he now most desired.

An old and honored inmate of the doctor's household was his mother. She was a nervous, fretful old lady, much troubled with sleeplessness. A window of young Linnæus's room was visible from where she tried to sleep, and she observed that, after this new comer had been in the house some weeks, a light seemed to be left burning in his room, if not all night, at least until well towards morning, when presumably it had burnt itself out. She reported the case to her son, and insistently, as a thing that ought by all means to be stopped. The whole house was in danger of destruction by fire. Dr. Stobæus had knowledge of students and their ways. In his own mind he doubted that this was a case of sleeping with the candles burning. He entertained a suspicion that the two companion youths would be found there, recreating themselves with cards in the small hours of the night. At two o'clock next morning, the room of

young Linnæus being illuminated, the doctor quietly made his way to the door, opened it and went in. The young man was found alone, at his study table, which was covered with open books. A step nearer the table disclosed the interesting and not readily accountable fact that all were books of botany, and out of Stobæus's own library that was always kept securely locked. To the question how he obtained those books from the locked library Linnæus answered in brief, and very frankly, that the other student had desired of him a course of instruction in physics; that he had begun the course, and was continuing it, upon the stipulated condition that he, who had free access to the library, should nightly bring him books of botany, which he himself would study late at night, so that they might be returned to the library shelves in the early morning before the household should be astir. Dr. Stobæus, suppressing the pleasure and approbation that were mingled with his amazement, said: "Go to bed, and hereafter sleep while other people are asleep." The next morning he sent for Linnæus to come to his study; asked him to rehearse again the story of how he obtained those books; then gave him a duplicate key to the library, together with permission to use it as freely as if it were his own. Moreover, as he had hitherto nothing but his lodging with Stobæus, he was now invited to take his meals at his table; was often sent to visit patients, and in every way treated with affectionate regard.

When nearing the end of his year at Lund, Linnæus fell dangerously ill. At the beginning of a slow convalescence they sent him to the parental home, the parsonage at Stenbrohult. Here his admiring first patron, Dr. Rothman of Wexiö, visited him. He was now ambitious that his former pupil, instead of returning to Lund, should enter the great university at Upsala, where men of renown occupied professional chairs, Roberg in medicine, and Rudbeck the younger in botany. The parents, in view of the quite marvellous successes of their boy during the two years that they had left him without financial aid, seem to have relented, and partly forgiven his having disappointed their wishes as to a vocation; and he was given some money with which to procure conveyance to Upsala and make the be-

ginnings of a career at that celebrated seat of learning; this, however, with the stern assurance that this was all they would be able to do; that no remittances from home would be forthcoming. Before the first year at Upsala was completed Linnæus was penniless and almost barefooted; being obliged to line his shoes with birch bark and pasteboard, and his clothing was worse than threadbare. He was now in the twenty-third year of his age, and in his distress he still consoled himself with studies botanical. In the midst of the botanic garden at Upsala he sat, one autumn day, drawing up descriptions of some rare plants that were in bloom. An ecclesiastic of distinguished bearing, in passing through the garden paused before him, asked him what he was describing, if he knew plants, was a student of botany, from what part of the country he had come, and how long he had been at the university, tested his knowledge of botany by asking him the names of all the plants that were in sight. This ecclesiastic was no less noted a personage than Olaus Celsius, a man then some sixty years of age, eminent as a theologian, an orientalist, and more than an amateur in the natural sciences; even now beginning to be a botanist; for some two years before the date of his chance meeting with the student Linnæus, he had been assigned by a council of Lutheran clergymen the task of writing a treatise on the plants mentioned in the Bible. His classic Hierobotanon was the result of his attempt to fulfil that commission; and, by the way, none will ever know how largely he may have been indebted to the young student Linnæus in the preparation of that work. The examination that he had given the youth, there in the botanic garden, had filled him with wondering admiration. Celsius saw that he needed him; saw also in his worn clothing and almost bare feet the evidence of a worthy student's grinding poverty. Within a few days Linnæus was comfortably housed with Professor Celsius; having been commanded to bring with him that herbarium of 600 Swedish plants which he said had accumulated with the last three years.

Celsius was to write a botany of Palestine by and by, and was now devoting as much time as he might to the botany that was at hand, that of his own country; and he had augmented his

great scholar's library by the acquisition of all the standard and many rare books of botany. Linnæus was again in the enjoyment of great good fortune. Yet all this was not for long. Celsius's very zeal and benevolence on his behalf brought the young man into trouble. By his great influence he procured for Linnæus an examination, which was followed by a license to lecture publicly in the botanic garden. The candidate had not been three years in residence, and Professor Roberg expressed it as his opinion that the precedent was a dangerous one to have established. The lectures were begun, and Linnæus had a throng of students of the best class, among sons of some of the university professors; and he was now able to clothe himself comfortably. This all happened at a time when a promising instructor, Nils Rosén, had lately gone abroad on a two years' leave, to obtain the doctorate in medicine. A less competent young man had been delegated to take Rosén's work during his absence. Linnæus, by his superior learning and personal magnetism, appears quite innocently to have drawn away his students. There would be trouble in store for Linnæus whensoever Rosén should return. It is a sad truth that, in science as elsewhere in this poor foolish world, the mediocre man in higher position must hate and if possible persecute the superior man in lower station, and that for his very superiority, if for nothing else. Rosén, on his return from abroad, with the doctor's degree won, besought of old Professor Rudbeck permission to teach botany himself, hoping thereby to draw from docent Linnæus all his students. Rudbeck declined to consider such a proposition, stating frankly that Dr. Rosén was hardly very well prepared to instruct in botany. Rosén's next move was successful. He procured the passage of an official regulation to the effect that no undergraduate should be permitted to lecture publicly, to the prejudice of a regularly appointed instructor. Such an instructor there was, in the person of the young man who had been appointed to teach in Rosén's place while he was absent. Thus was Linnæus deprived of the means of living any longer at Upsala.

JOURNEY TO LAPLAND.

Inasmuch as his lecturing in the botanic garden had been under Rudbeck's jurisdiction, and the latter had become much attached to the young man, he had taken him into his own household. Rudbeck himself had been the earliest botanical explorer of Lapland, and, by frequent rehearsal of the wonders he had seen in that wild hyperborean realm, he had enkindled in the young Linnæus a keen desire to go there. The Swedish government had long thought its own territorial possessions there to be worth investigating from scientific and economic points of view.

It was now soon arranged that Linnæus under the auspices of the Academy of Sciences at Upsala, should make an expedition to Lapland for purposes of scientific exploration. He set forth from Upsala on the thirteenth of May, 1732, returning late in autumn. It had been a journey of some 2,500 miles, made alone, for the most part, and almost everywhere on foot; but this was one of the most fruitful seasons of his whole life, though he was now but twenty-five years of age. His Flora Lapponica, together with the narrative of the journey, are among the most instructive and fascinating reports of a scientific expedition ever written. In the day when they were new they were unequalled in the literature of scientific travel; and the Flora Lapponica would have secured a deathless fame to any botanist, even if he had written nothing else.

JOURNEY TO GERMANY AND HOLLAND.

After the return from Lapland, the next two years were passed in teaching publicly and privately, at one place and another in Sweden, mostly at Fahlun; but also at every spare hour of time working industriously at the manuscripts of several books — the Flora Lapponica and others — which he was all the while hoping soon to be able to give to the public. At Fahlun he won the esteem and friendship of the Rev. Johan Browallius, at that time private chaplain to a certain nobleman, subsequently a professor at the University of Abo, and Lutheran bishop of that diocese. This man urged Linnæus to circumvent his powerful antagonist at Upsala by going abroad, and

taking his degree in medicine at some foreign university. Following this counsel Linnæus, in the beginning of the year 1735, sailed for Germany and the Netherlands; taking with him a finished medical thesis for presentation at some school of medicine, and also the manuscripts of several books of botany. Before the end of June he had passed the examinations, successfully defended his thesis, and obtained the degree of Doctor of Medicine; this at Hardewyk in Holland.

The primary object of his trip abroad having been attained, there were reasons why he might have been expected to take advantage of the first opportunity that should present itself for his return to Sweden. Before leaving his native land Linnæus had acquired what is said to be easily gained by even a poor young man when he happens to be of good presence, polite accomplishments and some personal magnetism; he had provided himself with a rich and elderly prospective father-in law. Said prospective father-in-law had returned the compliment by providing Linnæus with some traveling funds and the needful university fees. Before bidding the prospective son-in-law farewell Dr. Moræus, as if endowed with some of that wisdom that men say comes with years, and as if doubting that the prospective bride would surely speed the young man's early return, enjoined it upon him that he must come back and begin the practice of medicine, whensoever he should have gained the doctorate.

But that which had long been uppermost in Linnæus's mind had been, not medicine, but systematic botany. In the direction of the latter all his ambition led him. The manuscripts of what he hoped would be immortal books of botany — and they became such — he had brought with him. No one in Sweden would have published them. In Germany, in Holland, and in France there were many and splendid botanical establishments, and several learned botanical professors of world-wide fame. His books if published must have the approval of these in order to insure for them success. He must see these men, ingratiate himself with them personally, show them his manuscripts, discuss with them the merits of his system; for it was new, and in its leading characteristics altogether revolutionary. His

money was now almost all gone, but what of that? He had often been in such straits before, but some provision had always hitherto been made for him.

Leyden was the seat of what, at the time, was the most celebrated university in Holland; and, for botanical gardens, and botanical celebrities who had taught there, was hardly second to Paris itself with its traditions of Tournefort and his successor, Vaillant. In Professor Paul Hermann's time, little more than a generation anterior to Linnæus, the Leyden Garden had been confessedly the finest and richest in the world. After Paul Hermann, Dr. Hermann Boerhaave had presided there. He had retired from the professorship three years before Linnæus's arrival in Holland, and was now at once the most famous physician in Europe and without a rival as an authority upon systematic botany. He was living in age and retirement not far from Leyden, and there was not another man upon the face of the earth whom Linnæus so much wished to see. He could not endure the thought of returning to Sweden without having visited this great Mecca of botanists, Leyden. Once there, he found friends in learned botanists nearer his own age, who had not yet published books, and of whom he had not heard. Among these, Adrian van Royen, professor at the university in succession to the illustrious Boerhaave; also Dr. Gronovius, a well-versed and ardent botanist. Others at Leyden who became Linnæus's cordial and helpful friends we must not stop to name. Both van Royen and Gronovius became enthusiastic over the young man and his manuscripts. Gronovius was so charmed with his Systema Naturæ that he proposed, with Linnæus's permission, to have it published at once, and the printing of it was begun. It came out, as a mere outline sketch of a new natural history. It was a folio tract of but fourteen pages, but it was everywhere received with the greatest applause. Meanwhile Linnæus had used every endeavor to see that great oracle of medicine and of botany, old Boerhaave, but in vain. Provided with a letter from Gronovius, he had called every day for a whole week, but to no purpose. Ambassadors and princes had found him accessible with some difficulty. Even Peter the Great, of Russia, had been obliged to wait two hours in an ante

room, to take his turn in getting a conference with this busiest and most imperious old prince of learning and master of the healing art. Linnæus now bethought himself to send a copy of the new Systema Naturæ. A letter came back, naming the day and the hour when he should be admitted to an audience. The interview was prolonged and was carried into Boerhaave's own private botanic garden, a place well stocked with almost all plants and trees that had been found to endure the climate of Leyden. One beautiful tree which Boerhaave thought—was even very certain—had never been described, Linnæus gave him the name for; also the volume and page of one of Vaillant's folios in which it was described fully and clearly. When they returned to the library, the place was found, and the truth was admitted. The venerable doctor advised the young Swede to settle in Holland, where he felt certain that his learning and talents would insure him wealth and great renown. But since Linnæus could not now prolong his stay at Leyden, Boerhaave desired him to take a letter from himself to his friend, Professor Burmann, at Amsterdam, the port whence Linnæus had proposed to sail for Sweden. He found Burmann, then much engaged upon his Botany of Ceylon,[1] so overwhelmed with work of several kinds, that courtesy seemed to require that he should make the call short. It was evident that nothing but the letter from that great scientific potentate Boerhaave, at Leyden, had procured him admission to Burmann's presence. On withdrawing, however, he was invited to call again. At the second call he found the Amsterdam professor less preoccupied. They went into the botanic garden. At the end of this interview Burmann was overwhelmed with a sense of the unexampled skill of this young Swede in botany. He had learned so much of him in that one hour as to see that he must secure, if possible, his help in the finishing of his great book of Ceylonese botany. Linnæus was invited to take up his abode with Burmann for the period of his sojourn in Amsterdam, and he accepted the bidding. He had been there about two months when he received a call from one of the merchant princes of Amsterdam, George Cliffort. He was a gentleman of culture as well as of great wealth, and

[1] Thesaurus Zeylanicus. 4to. 1737.

had a very noble garden, and conservatories abounding in rare plants from the Indies and other remote places. But his errand with Linnæus was not botanical. He was something of an invalid, and melancholy. His regular physician was Boerhaave, at Leyden. On a late visit to him, Boerhaave had advised him that his ailments were chiefly resultant from his princely ways of living; that he could not do better than employ the services of a brilliant young Swedish physician, a specialist in dietetics, at present the guest of Professor Burmann. He advised him to take Doctor Linnæus for body physician into his own house, and place himself under his direction as to diet. This was Clifort's motive in calling upon Linnæus. The outcome of it was an agreement between them; and the young physician botanist was soon quite luxuriously domiciled with Cliffort, and under good pay. Charmed with the Cliffortian garden and conservatories, and seeing there many a plant unkown to botanists, Linnæus counseled the preparation and publication of an illustrated folio, that might fitly be entitled the Hortus Cliffortianus, in which the rarities and novelties growing there should be brought to the knowledge of the world botanical. Of course the proposition delighted Cliffort and the work was done. That most luxurious of all Linnæus's works, the Hortus Cliffortianus, he assures us, was written in nine months. It was published in Amsterdam in 1737, when Linnæus was thirty years old. But besides this, there had already been published, since Linnæus had come to Amsterdam, the Bibliotheca Botanica, and the Fundamenta Botanica, in the year 1736; and there now followed the Flora Lapponica, the Genera Plantarum and the Critica Botanica, all in the year 1737; some of them issued at Amsterdam, others at Leyden. This represents the most wonderful beginning at botanical authorship of which there is any record. Here were seven learned and forceful books, two in folio, and five in octavo, all given to the public within two years, almost a library of botany, and that a new botany, and so easy to comprehend, that almost any educated person could now acquire proficiency in botany by these books alone as a guide. The system was a new one; evidently a rival system to that of Tournefort, which had now been dominant for forty years. All the botanical world

was in amazement; and the author, having now been three years abroad, and having made his personal impression upon nearly all the botanists of London and of Paris, as well as upon those of Germany and Holland, went home to Sweden, there at first to suffer the adverse consequences of fame, and afterwards to enjoy its benefits.

PRACTICES MEDICINE IN STOCKHOLM.

To suffer, I say, the consequences of renown; for Linnæus had now to realize the truthfulness of what was said by the Great Master of long ago; namely, that "a prophet is not without honor, save in his own country, and in his own house." At the University of Upsala now, as aforetime, there was no hope of preferment for Linnæus. His books did not as yet bring him income. He must settle down to the practice of medicine; and he chose Stockholm, the capital and chief city of the kingdom. There he was a stranger. Their was not one friend to recommend him; and, as he himself records it, no one would employ him, even by committing a sick servant to his care. His system of botany began also to be assailed in public vigorously and tellingly. Just across that arm of the sea that separates between Sweden and Russia, at St. Petersburg Professor Siegesbeck had written and distributed a book in which the Linnæan system of botany was arraigned severely, and with so much point that many people in Sweden thought that Linnæus had been philosophically and botanically annihilated. He admits that he almost believed that himself; and, as now the tide had set strongly in his favor as a medical practioner at Stockholm, he had resolved to abandon forever the service of Flora, and devote himself wholly to that of Æsculapius. The latter, said Linnæus, brings all good things, while Flora rewards me only with Siegesbecks. And the tide of Linnæus's fortune in medicine rose higher. One and another of the nobility became numbered among his patients, and at last, the queen herself; and now, as he said in a letter to a friend, no one who was ill could get well, it seemed, without his help.

APPOINTED PROFESSOR AT UPSALA.

Court influence now procured him the comfortable position of Physician to the Admiralty. After that, the death of Dr. Roberg, professor of medicine at Upsala, opened the way to Linnæus's promotion to a professorship at that university. It was that of medicine, and that of botany was, at the time, held by Linnæus's former antagonist Rosén. The two professors, now equal in official rank, became reconciled and, with the full consent of the authorities, exchanged professorships. Linnæus was now again a botanist. He was still a young man, only some 34 years of age, and had lived out not quite half his days. The after years, those of his fruition, did not produce as much of importance to botany as the earlier period had yielded. There came out in 1751 the Philosophia Botanica, partly of the nature of a recension and enlargement of two of his early books, the Fundamenta Botanica and the Critica Botanica. It is one of his most important and imperishable books. In 1753 appeared the largest and most comprehensive of his works, the Species Plantarum. During the remaining years of his life Linnæus was largely occupied with the preparation of new editions of almost all his works, the public demand for which was very great.

INFLUENCE OF LINNÆUS UPON BOTANY.

It is not possible to convey an idea of what Linnæus accomplished for the advancement of botany without presenting, in brief outline, a view of what had been done before him. That there was not much botany before Linnæus, is a fable that gained popular credence in rural districts a half century ago. One of the earliest books which our Linnæus published was the Bibliotheca Botanica. It contains the titles of 1,000 volumes, by almost as many different botanists, most of which books he thought an indispensable part of a working botanist's equipment; and his own works, on almost every page, abound in citations of those of his predecessors. The first foundations of scientific botany had been laid by Cæsalpino, an Italian physician, and university professor of botany, 124 years before Linnæus was born. He selected his granite blocks of principle so well, and laid them so securely, that the superstructure of modern sys-

tematic botany rests upon them. Every variation of botanical system that has been builded in the last 324 years has rested on the Cæsalpinian foundation, *i. e.*, that in the fruit and seed of plants we have the key to their affinities. Not one of the great geniuses botanical in later times who have most advanced the science has questioned the validity of that principle. Not one has yet dared to predict that the Cæsalpinian foundations are likely ever to be abandoned as insecure.

The earlier disciples of Cæsalpino made many amendments and signal improvements of his system, through further study of floral structure, as furnishing yet other clews to plant affinities. The summing up of these many improvements was made by Tournefort, whose Elements of Botany, published in 1694, 111 years after Cæsalpino's great work, and 13 years before the birth of Linnæus, took the whole botanical world captive, and held undisputed sway, until everywhere but in France, the native land of Tournefort, they were superseded by the system of Linnæus.

To the botanists present who are unread in the history of our science, nothing will be more surprising than the information that, with the great Tournefort, who founded upon the flower the most universally approved system of botany which, up to that time had been presented, the flower was hardly anything more than what we know as the corolla. Of the functions of stamens, stigmas and styles he was ignorant, confessed his ignorance, and regarded them as wholly insignificant things, hardly to be seriously taken note of. The flower and the corolla were with him almost synonymous; and yet so uncertain was he in his identification of the corolla that, where, as in all the Araceæ, it is absent, he took the spathe for the corolla; while in such apetalous things as the castor bean, he regarded the brightly colored stigmas as the corolla. Such extremely crude ideas of floral structure were those of Tournefort to the end of his career; and he died when the infant Linnæus was one and one half years old.

Now the Linnæan doctrine of the flower and that of Tournefort represent opposite extremes. To be more specific: while Tournefort's conception of the flower as an organism is about

as crude and imperfect as can well be imagined, that of Linnæus is almost perfect. In the view of the former the one important organ is the corolla, the stamens and stigmas nothing, or next to nothing; according to Linnæus, the stamens and stigmas, with the ovary, are the only essential organs of the flower, the corolla relatively unimportant. All the world botanical now understands that the philosophy of floral structure upheld and most effectively promulgated by Linnæus was the right one. The actual discovery and demonstration of this new and revolutionary anthology are not attributable to Linnæus. In the year that the small boy Linnæus left home for the Latin school at Wexiö, a new incumbent was installed into that professorial chair at Paris which Tournefort had occupied. The new professor had been one of the pupils of that celebrity. His name was Sebastian Vaillant. The subject of his inaugural address was The Structure of Flowers. In this address, soon afterwards printed, Tournefort's anthology was completely undermined, and what was offered in the place of it became the accepted anthology of the remaining 80 years of the eighteenth century, of the whole of the nineteenth, and is thus far that of the twentieth. In other phrase, that doctrine of the organization and the functions of the flower which Vaillant set forth as new in the year 1717, has held undisputed sway, without significant augmentation or amendment, for now 190 years. Every botanist will readily perceive that this is a very rare encomium. Every one will realize that to very few can it have been given to lay down the fundamentals of plant taxonomy. Those fundamentals, as we have all been taught, and as our forefathers were taught, are really only two, namely carpology and anthology. Cæsalpino in the year 1583 established the true carpology. Vaillant in 1717, the true anthology. These were the two great things to be done before there could be a true and philosophic system of botanical classification. Now which of these two names is greatest in scientific botany may be open to learned dispute; but so long as the accepted foundations of botany remain in place, successful competitors for their exalted rank there can be none.

Five years after having published this masterpiece of plant

organography Vaillant died. His death occurred on his fifty-third birthday. He also died unthanked for the greatest of several great things that he had done for botany. All the world botanical still idolized the memory of the great and popular Tournefort; and it resented that virtual overthrow of his whole system which this remarkable former student of his had accomplished. Universally, and bitterly they charged him with ingratitude. And so that inaugural address, in which this far greater man than Tournefort had given to his science the very best that was in him, became an offense to the blind invidious multitude. When they should have praised him, they blamed him; and he lay down and died.

But afar in the north, in the land of giants mythical and giants real, there was an ungigantic youth of great mind and of noble soul, who would champion most successfully the cause of Sebastian Vaillant; and in so doing create a new system of botany that should supersede that of Tournefort.

It was in the year 1729, when Linnæus was in his twenty-third year, and a student at Upsala, that he first became acquainted with Valliant's great tract; learning from it that those obscure and long neglected stamens and pistils were sexual organs and the only really important parts of any flower. This being true, it was plain to him, as it had been to Vaillant, that Tournefort's classes of plants established upon the corolla as the essential organ, were unphilosophically and untenably based, and must fall. From that day Linnæus determined to work out a new system of classes and orders of plants, on the basis of stamens and pistils as the most important floral organs. The result was 24 classes of plants established upon characteristics of the stamens, instead of the 22 classes of Tournefort distinguished by differences in the structure of the corolla. The Linnæan classes were very much more easily learned than the Tournefortian. His Class I embraced all genera of plants the flowers of which have but a single stamen; Class II, those which have two stamens, and so on up to Class X, when other considerations, still in part numerical, were seized upon. Any mere beginner in botany, with a plant in flower before him, could determine its class without even opening the book. If the

flower exhibited five stamens the plant was sure to belong to some genus of Linnæus's Class V. If the same flower showed also two pistils, that indicate as unmistakably Order 2 of Class V. No other system of plant classification ever invented made the beginnings of botany so easy; no other ever was so immensely popular. But, what is much more to the credit of the Linnæan classes and orders than the popular applause with which they once were hailed, is the fact that the determination of plants under them necessitated close inspection of all, even the minutest and obscurest parts of every floral structure; trusting that in these minute, obscure and hitherto neglected organs there would be found some of the very best indexes of affinity. This line of investigation, so important to all taxonomy, Linnæus was the very first to carry into practice and make universal. It will be difficult to bring the average botanist of to-day to a realization of how great an epoch in botany Linnæus created when he began examining the stamens of every plant, with the purpose of ascertaining into what one of his 24 proposed classes of flowering plants each generic type must fall. And though it be true that the classes and orders of Linnæus fell into disuse three-quarters of a century ago, it is true to-day that every botanist, from the mere beginner in taxonomy to the most accomplished master of it, if he have a new and unknown plant in hand for determination, makes his final appeal to stamens and pistils. These, by peculiarities of structure, will tell the plant's relationship in many an instance, both promptly and decisively. In this procedure, every botanist who lives is distinctly a disciple of Linnæus; for he, putting Vaillant's principles into taxonomic practice, first inaugurated the method, and eventually brought to pass its universal recognition and its permanent establishment. When in the year 1735, with those manuscripts of his new botanical system, Linnæus went to Germany and Holland, he had now for seven years been scrutinizing carefully and industriously the stamens of everything that had come to hand. By dint of those seven years of industrious investigation of these organs he had not only become a very expert in this line, but he was the only man in the world who knew anything about the morphology of stamens. He was now, to the

oldest and most experienced systematists of Europe, a perfect marvel on account of the readiness with which he could solve for them some of their most perplexing taxonomic puzzles. I can not stop to cite more than a single instance. In one of the larger Dutch herbaria, there was a rare specimen of the leaves and flowers of a certain oriental tree. The bark of this kind of tree had been known in Europe as a commercial importation for, I think, some 2,000 years. They called it cinnamon. As a generic type the tree had been named in Latin *Cinnamomum*. The professor gave Linnæus the information that these were the leaves and flowers of the cinnamon tree; but what were the natural affinities of the tree? Had it consanguinity with any other known tree? To what was it related? These were questions which not the most expert botanists could answer. The fruit of the tree was not yet known, and therefore could not be appealed to. The flowers were small and insignificant. Linnæus took one of those small dried-up flowers, subjected it to moisture, so that he could get a view of the anthers without breaking them, then, looking at these alone, was able to answer, with the most perfect assurance, that this cinnamon tree is a very near relative of the familiar sweet bay of southern Europe; a species of the genus *Laurus*. The man's frequent solving of enigmas like this, in the presence of the most learned and capable botanists of the world, brought it to pass that he was spoken of everywhere among the Germans and Flemish, as the little oracle; for when he gave a decision about the affinity of any imperfectly known plant, he was admitted to be correct. It was as if an oracle had spoken. These brilliant pronouncement must also have prepared the way for that great success which his publications met with, and that ready adoption of his new system which followed almost everywhere despite its character as radical and revolutionary.

If, then, Linnæus, at the time when he began publishing the fundamentals of his new system occupied a place wholly unique among botanists then living as to knowledge and understanding of floral structures of all kinds, so that the oldest and ablest among them stood in speechless admiration of his superlative attainments, there was forthwith exerted by him a most salutary

influence upon the important art of plant description. The revolution which he at once brought about in the art of generic diagnosis was perhaps the most priceless of his several strong contributions to phytography. In his Genera Plantarum of the year 1737, every genus is so well characterized in words, that plates and figures illustrating them are not needed. The group which Linnæus takes for a genus is even more clearly defined by his few descriptive sentences, than is a genus of Tournefort, in which the defects of its description are eked out by a fine quarto plate representing the type. And the reason why Linnæus surpassed immeasurably every author who had preceded him in the practice of generic diagnosis was that he had all their understanding and appreciation of calyx, corolla and fruit, and added to that his mastery of stamens, stigmas and styles, the very names of which were unknown to the generations that had preceded him, and hardly yet known to the most celebrated of his contemporaries. In the later editions of the Genera Plantarum, no improvement is to be noted in his diagnoses. They were models as he gave them out at first, at least as viewed from the standpoint of Linnæus's acknowledged greater master, Cæsalpino. They are still essentially the models of generic diagnosis with all who still hold the Cæsalpinian doctrine that flower and fruit are to supply the only recognized data for the establishment of classes and genera of plants. Even George Bentham, who lived more than a century after the time of Linnæus, and was the supreme master of generic diagnosis that the nineteenth century knew, was strictly a Linnæan in this regard; so that here, as at many another important point in the most recent botany, the genius of the great Linnæus rules and directs.

Fellow members of the Botanical Society of Washington, if this had been a meeting of our own, and not that of two other learned societies in joint session with us, I should have preferred, as I said at the beginning, to discuss some one of Linnæus's greater books; taking it as a text from which to set forth his deeds; his many benefactions to our science. To some it will doubtless appear anomalous that here, not so much as the briefest abstract of his various reforms in nomenclature should be given: especially since, in the minds of so many botanists

of recent decades, those reforms are thought to be the most important service that Linnæus rendered to botany. Several of the most commonly received opinions about him as nomenclator are absolutely groundless. Several principles of nomenclature now almost everywhere approved were under his severest reprehension. Inasmuch as I myself was the prime mover in the direction of what has now come to be well known abroad as the Neo-American school of nomenclature, I may be permitted to say that during more than twenty years past I have steadily and unwaveringly been of the opinion that, to attempt to legislate upon nomenclature is but futility, if not folly, until every participant in every nomenclatorial conclave shall have familiarized himself with all that Linnæus said, and said with such commanding authority, upon this subject. So, then, the discussion of Linnæus as nomenclator, at least in my understanding and appreciation of him, could not alone be done within the time allotted us to-night. To omit it altogether was imperative.

The same limitations have precluded my calling attention even briefly to Linnæus as evolutionist, as ecologist, as medical botanist, or as one who contributed much to the advancement of what is now commonly spoken of as applied botany in general.

Of the real merits of Linnæus they know little who, observing that his classes and orders are become obsolete, and that neither his idea of a genus is that of more recent botany, nor his conception of a species, conclude that his figure must by and by grow dim on the horizon of botanical history. I say, they who know little of his real merits may give place to such forebodings. But they who fully realize what he accomplished in so many different directions to the great and lasting advantage of our science, will be rather disposed to wish that an equal of Linnæus might soon be born; and might think it well that the natal day of the matchless Swede should be held sacred not only once in each century, but a hundred times in every hundred years.

LINNÆUS AS A ZOÖLOGIST.

By Dr. William H. Dall.

I have been asked to make a few remarks on the relations of Linnæus to zoölogy. After the comprehensive addresses to which we have listened, you would be well within your rights if you complained that a review of the systems and conceptions for zoölogy, entertained by Linnæus, was, on the present occasion, inopportune.

I shall attempt nothing so ambitious, or I might almost say, for a public address, so tedious.

Viewed in a broad way, the services of Linnæus to zoölogy were of several kinds.

The first and greatest, though at the time of its conception regarded as relatively unimportant, was the invention of what has long been known as the binomial or Linnæan system of nomenclature. The conception of a permanent name for each type of organized beings, thereby giving to the naturalist a concise method of indicating each unit of the system, was so great an advance on any previous method of handling zoölogical species that it amounted to a complete revolution in methods; comparable to that for the arithmetical sciences, which followed the adoption of the decimal Arabic symbols in place of the clumsy Roman notation of numerals.

That previous zoölogists, like Rumphius, had more or less inadvertently approximated to this system at times, while giving names to animals, does not diminish the credit due to Linnæus for erecting the method into a definite system emphasizing the principles of permanency and priority, and elaborating its details.

The second service was that of holding up the animated creation as an interrelated whole. This grasp of the subject would be impossible to a naturalist of the present day, were the multitudinous units of the animal kingdom now known, presented to him in the chaotic state in which Linnæus found the little micro-

cosm which he had to deal with. The progress, by the Linnæan methods, since his time, has been so great; anatomical, ecological and embryological discoveries have so illuminated the subject; that we are prone to look with amusement on the crude classification which alone in his time was possible, without appreciating the instances it contains of really astonishing insight into the true relation of organized beings.

It is only when we compare the Linnæan classification with the contemporaneous absurdities of such antagonists as Jacobus Theodorus Klein, who in bewigged pomposity stares at us from the frontispiece of his ridiculous "Tentamen," that we can appreciate the quality of the genius of the immortal Swede.

A third manner, and by no means the least important, in which Linnæus influenced zoölogical science, was through his friends, associates and pupils. We all know what the personal influence of Louis Agassiz did for science in America. Something of the same sort emanated from the personality of Linnæus in his time.

In the days of his early struggles it must have been evident, or we should not read of how such men as Rothmann, Stobæus, Celsius, Rudbeck and Reuterholm exerted themselves to promote the fortunes and facilitate the studies of the poor country parson's son. A little later, as he began to win a footing, we find the greater scientists with whom he was brought in contact giving him a cordial welcome; and, from men like Gronovius, Boerhaave, Burmann, van Royer and Cliffort in Holland; Artedi in Sweden; Jussieu in France; Haller in Germany and Dillenius in England; such recognition was no feeble testimony to his influence and worth. Still more conclusive are the relations to Linnæus of such ornaments of the nobility as Counts Tessin and Gyllenborg, and her Majesty Queen Ulrica, worthy precursors of the liberal-minded nobles of to-day, and their leader, His Majesty of Sweden, always foremost in promoting science, exploration and the arts, to the true glory of his kingdom.

From every other civilized nation as well as from Sweden, Linnæus drew pupils. Those conversant with the dawn of science in the modern sense, will find familiar the names upon the roll.

First, as true martyrs of science, who gave their lives, by pestilence or accident in foreign lands for the promotion of discovery, are Ternstrom who died in China; Hasselquist in Smyrna; Forskal in Arabia; Loefling in South America; and Falk in Tartary.

Those, more fortunate but not less daring who adventured in foreign lands and by a safe return were enabled to reap, in their lifetimes, a reward of merit, were Peter Kalm in North America; Rolander in Surinam; Toren in Malabar; Osbeck in China; Sparrman in South Africa; Thunberg in eastern Asia and Japan; Niebuhr in Egypt; Gmelin in Siberia; and, in various parts of Europe, Koehler, Alstroemer, Von Troil, Fabricius, and Solander.

I have mentioned but a prominent few among many. A little leaven leaveneth the whole lump. That influence which drew and held students, which inspired them to their utmost efforts, faithful in the quest of knowledge even unto death; which helped to mould a second generation to carry on the work of research; which affected more or less deeply every student of nature in the last quarter of the eighteenth century, and has not yet spent all its force; that influence was no trifling gift to mankind.

The details of work accomplished by Linnæus, as by each and every one of his successors, fluctuate in value under the keener scrutiny and more refined methods of those who follow after. The fate of theories lies in the lap of the Gods.

But the spirit which inspired them; the ardor which hands on the torch as the runner sinks exhausted by the way; the devotion to truth and disregard of self imparted by a great teacher; and which shall endure while a human mind and heart exist to cherish them — these are gifts immortal.

PROCEEDINGS

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. IX, PP. 275–522. OCTOBER 18, 1907.

A REVISION OF THE AMERICAN COMPONENTS OF THE TENEBRIONID SUBFAMILY TENTYRIINÆ.

BY THOS. L. CASEY.

SEVERAL of the groups reviewed in the following pages have formed the subject of previous study on the part of the writer, either monographically, as in the case of the genera allied to *Eurymetopon*, or as detached new species, and the present opportunity is embraced to give a connected view of the entire series, in that part of the great family Tenebrionidæ having the abdominal segments unmodified by a coriaceous hind margin and the middle coxæ enclosed externally by the sterna alone, without the intervention of a small piece attached to the coxæ and sometimes separating the sterna, known as a trochantin. This is the definition of the subfamily Tentyriinæ as given by LeConte and Horn, and is adopted for the present revision, although reasons will be given further on for a belief that it is not an entirely natural subdivision, there being two great groups included, characterized principally by the development of the mentum, which apparently affords a better line of delimitation for subfamily groups than the presence or absence of a trochantin. However, this is more a matter to be discussed in a general revision of the family than at the present time, and the following work is presented simply with the hope that it may prove useful in giving some slight conception of a problem in classification, the difficulties and uncertainties of which are well known. Perhaps the most perplexing feature pertains to the differenti-

ation of the genera, and I may have overstepped the limit of prevailing conservatism in proposing so many of them, but it seems certain that the proportion of wholly unnecessary names: that is, titles that are not at any rate subgeneric if not fully generic, will prove to be very small indeed. The limitation or extension in scope of genera and subgenera is, with the discovery of more complete material, becoming increasingly arbitrary and opinionative.

As in all of the more recent investigations of the writer, as much foreign material as possible has been accumulated for study in connection with our own, and this method is recommended to all those who would attempt systematic work upon a restricted fauna, as being more liable to produce results that may be valuable to a general monographer, if, in the future, there may develop anyone willing and able to take up such a life work as a general monograph of the larger families of Coleoptera is rapidly becoming. The foreign groups thus included for comparison are indicated, as formerly, by a prefixed asterisk in the tables of tribes and genera.

WASHINGTON, June 10, 1907.

Order COLEOPTERA; Family TENEBRIONIDÆ.

Subfamily TENTYRIINÆ.

The Tenebrionidæ in general have ever been a stumbling-block to the systematic investigator, for the reason that radical structural divergencies, constant through extended groups, are so few in number and minor group characters, in all manner of unexpected directions, so infinitely varied. In considering the Tenebrionidæ of the world, even so talented a morphologist as Lacordaire found these troubles practically insurmountable, and it is therefore with diffidence that I venture here upon a pronounced departure from the usual succession and arrangement of the numerous tribes of the subfamily Tentyriinæ, as defined by LeConte and Horn.

By studying carefully some of the palæarctic types of the Tenebrionidæ, I find the apparent relationships of some of our more isolated genera, such as *Craniotus*, which is evidently the

American representative of *Adesmia* and *Stenocara*, and further observation shows that in *Adesmia* and *Craniotus* we have the closest approach, among the Tentyriids with large mentum, to our remarkably specialized Zopherini. These facts suggest at once the reversal in order presented by the following rearrangement. The very isolated *Zophosis* of the old world fauna, which has there no close relative, seems to have its nearest neighbor in our Epitragini, which, although a generally winged type, presents many suggestive resemblances, such as the prolonged prosternum and excavated mesosternum, as well as the presence of two metasternal grooves before the posterior coxæ, the significance of which is wholly unknown. In *Zophosis* these lines are very oblique, conforming somewhat to the unusually oblique coxæ, and retreat broadly from the latter outwardly, though having the same point of origin as the transverse grooves of Epitragini and many other of our new world types, principally prevailing in those tribes characterized in general by developed hind wings. The equally isolated Erodiini of the old world are passably represented by our *Edrotes*, which should form a tribe of itself and apart from *Epiphysa*, because of its widely different coxæ and tarsi, as well as the unusual epipleuræ. Such aberrant types as *Chilometopon*, which Horn referred quite erroneously to the Epitragini, and *Trimytis*, with some of the Mexican forms recently described by Champion, fall satisfactorily into a special tribe, related very closely to the Eurymetoponini, and *Conœcus*, which the systematist mentioned referred with equal error to the Gnathosiini, is very plainly an Epitragid. The singular genus *Auchmobius*, which I regret being unable to observe in nature, appears from the remarks published by Dr. Horn, particularly concerning the aberrant mandibles and antennæ, to necessitate a tribe of its own, perhaps combining some of the characters of the Trimytini and Eurymetoponini.

With these preliminary remarks the arrangement of the tribes represented by material known to me may be presented as follows: —

Mentum very large, concealing both ligula and maxillæ.....2
Mentum generally smaller in size, never concealing both the ligula and maxillæ.....14

2 — Anterior tibiæ with a single terminal spur and a submedian external tooth; mandibles grooved externally throughout their length; mentum hexagonal, feebly sinuate at tip; intercoxal process of the abdomen narrow, subacute or slightly rounded; scutellum distinct; metasternum with transverse ante-coxal grooves; hind wings well developed.....**Cnemodini**

Anterior tibiæ with two terminal spurs, not toothed externally near the middle in any American genus; mandibles never grooved externally except in Erodiini.....3

3 — Posterior coxæ more or less narrowly separated, the abdominal process acute to broadly rounded.....4

Posterior coxæ widely separated, the abdominal process broadly truncate; metasternum without ante-coxal grooves, short, the body wingless; elytra frequently costulate.....11

4 — Elytra not embracing the sides of the body, the inflexed parts occupied wholly by the epipleuræ — or epipleural "repli" of Lacordaire.....5

Elytra embracing the sides of the body, the inflexed parts not wholly occupied by the epipleuræ.....10

5 — Mentum hexagonal, with the apex more or less distinctly emarginate or sinuate.....6

Mentum transversely parallelogramic, the apex very broadly arcuate from side to side and not sinuate at the middle, generally much more transverse.....9

6 — Front without a prolonged epistoma clasped by the mandibles, the frontal margin transverse and more or less feebly modified, the right mandible at least generally with a tooth which clasps the labrum only; antennæ slender, with the outer four joints broader; scutellum well developed; metasternum with ante-coxal transverse grooves; body generally winged, though often apterous. **Eurymetoponini**

Front with the epistoma abruptly prolonged.....7

7 — Epistomal lobe clasped by the superior external ridge of the mandibles; antennæ filiform, generally with the last four joints larger.8

Epistomal lobe not clasped by the mandibles, which are folded beneath it out of sight from above; antennæ gradually enlarged and compressed outwardly..... .....**Auchmobiini**

8 — Scutellum well developed as in Eurymetoponini; body winged or apterous, the metasternum with or without ante-coxal grooves. **Trimytini**

Scutellum extremely minute or obsolete; body wholly apterous; metasternum always very short, without trace of ante-coxal grooves. **Trientomini**

9 — Metasternum with transverse grooves parallel to the hind coxæ, the body generally winged, the epistoma lobed and the scutellum well developed..... .....**Epitragini**

10 — Metasternum with oblique grooves homologous with the transverse ante-coxal grooves of preceding tribes; epipleuræ very wide, occupying virtually the entire inflexed sides of the elytra; scutellum wholly invisible; mentum hexagonal, sinuate at tip; antennæ slender; mandibles generally bifid at tip, folding under the labrum, the frontal margin not greatly modified; tibial spurs greatly developed; body oval, apterous.....*Zophosini

Metasternum with very fine abbreviated transverse grooves, short, the body wingless, oval in form; epipleuræ narrow, entire as usual; eyes not prominent; scutellum invisible; mentum more transverse, sinuate at tip; antennæ slender; mandibles bifid at tip, strongly toothed above and clasping the sides of the prolonged epistoma; tibial spurs short as usual.....*Capnisini

Metasternum without grooves, short, the body oblong or elongate, wingless; tibial spurs, mentum, eyes, epipleuræ and tip of the mandibles as in Capnisini; antennæ very stout; front variable in form; scutellum visible but small, always strongly angulate; elytra as in Capnisini, without punctured series, though sometimes with impressed lines..... *Gnathosiini

Metasternum, tibial spurs, mentum, epipleuræ and tip of the mandibles as in Gnathosiini; antennæ very slender; front variable in form; scutellum distinct, always transverse and very obtusely truncate, generally not entering between the elytra behind the invariably pronounced basal margin; eyes coarsely faceted; body elongate, wingless, the elytra oval, with punctured series. Triorophini

11 — Mesosternum elevated, flat, abutting closely and on the same plane against the apex of the flattened prosternal process; hind coxæ transversely oval, only moderately abbreviated transversely. 12

Metasternum not elevated, discontinuous with the prosternum; hind coxæ small, oval, very much abbreviated transversely; eyes finely faceted; legs long and slender..... 13

12 — Body pilose, with broadly inflated elytra and narrower porrect anterior parts, the front with a strong epistomal projection clasped by the mandibles, which are bifid at tip; antennæ slender; scutellum invisible; epipleuræ obliterated anteriorly from near the base of the abdomen; metasternum longer than the first ventral; intercoxal process of the abdomen only moderately wide and broadly rounded.....Edrotini

Body broadly oval, glabrous and compact, the prothorax closely fitted to the elytra throughout the basal width of the latter; epistoma sinuate, not produced; mandibles small, folding beneath the labrum, deeply grooved externally but with the groove not attaining the bifid apex, the lower margin externally very acutely ridged; antennæ very stout; scutellum invisible; epipleuræ entire but very variable in form; metasternum extremely short, much

shorter than the first ventral; middle and hind coxæ extremely widely separated; anterior tibiæ with the outer angle prolonged into a slender spur, the outer side strongly toothed at the middle. ***Erodiini**

13 — Epipleuræ more or less narrow but distinct and entire; body narrow anteriorly, with elongate-oval elytra, glabrous; head not lobed at the sides, the epistoma sinuato-truncate, the mandibles folding beneath the labrum; mentum truncate at base, feebly sinuate at apex; antennæ long, slender, with the outer five joints more or less broader; scutellum invisible; middle coxæ moderately, the posterior very widely, separated, the hind coxæ almost attaining the sides of the body and subglobular.....***Adesmiini**

Epipleuræ wholly wanting, except toward the apex of the elytra, where they are very narrow; body formed as in Adesmiini but pubescent, the middle and hind coxæ similar, the latter not approaching so closely to the sides of the elytra; head strongly, angularly lobed at the sides, the epistoma and mandibles as in Adesmiini, the mentum sinuate and impressed medially at base and deeply sinuate at apex; antennæ filiform, slender, with joints eight to ten gradually larger, the eleventh attached as a terminal process of the tenth; scutellum well developed, acutely triangular. **Craniotini**

14 — Elytra without true epipleuræ; anterior coxæ separated.....15

Elytra with clearly defined entire epipleuræ.....18

15 — Antennæ very long, slender and filiform; body slender, the eyes on the sides of the head, convex and more or less prominent; maxillary palpi very long, the last joint elongate, arcuately truncate; scutellum well developed, semicircular; elytra costate; mesosternum greatly prolonged before the coxæ; met-episterna clearly delimited; hind coxæ large, widely separated; legs long. *** Leptodini**

Antennæ very small, compact, generally received in fossæ; eyes concealed in repose..... 16

Antennæ moderately long, thick, filiform and perfoliate, usually scaly, free; legs short and stout.....17

16 — Eyes very minutely faceted, flat, transverse, becoming approximate above; antennæ received within deep entire prosternal fossæ, the last three joints fused into an oblong solid club; mentum small, largely concealing the ligula, which is short, broad and densely hairy, the labial palpi wholly invisible without dissection [attached at the sides — Lacordaire]; tarsi deeply grooved beneath; mandibles truncate; scutellum invisible or minute; body elongate, suboval, convex, with smooth but tuberculose integuments..... .....**Zopherini**

Eyes minutely faceted, flat, more widely separated above; antennæ more slender, sometimes received in fossæ, never having the last three joints fused; mentum small, leaving the maxillæ and much

smaller ligula entirely exposed, the labial palpi distinct; tarsi and scutellum variable; mandibles bifid at tip; body oblong, depressed, very roughly and densely sculptured.....**Nosodermini**

Eyes coarsely faceted, more rounded; antennæ received in dorsal cavities, short and stout, the last three joints free, dilated, forming a very compact 3-jointed club; mentum, ligula, mandibles, labial palpi and form and rough sculpture of the body nearly as in Nosodermini; scutellum very minute; body much smaller in size..... **Usechini**

17 — Scutellum obsolete; body elongate, the elytra more or less inflated, costate; mentum large, closely filling the buccal opening, completely covering the maxillæ but exposing the ligula in a large apical sinuation; eyes very widely divided and coarsely faceted .....*Adelostomini

Scutellum extremely minute; body slender, with oval, inflated, costulate elytra; mentum moderate, subquadrate, not filling the oral opening and not sinuate at tip; eyes coarsely faceted, narrowly divided .....**Araeoschizini**

18 — Spurs of the anterior tibiæ minute or obsolete.....19

Spurs of the anterior tibiæ longer and distinct.....22

19 — Antennæ thick, subfiliform, moderate in length and perfoliate as in the two preceding tribes.....20

Antennæ very small, slender and compact; anterior coxæ separated; body glabrous.....21

20 — Anterior coxæ separated as usual; body elongate, convex, glabrous, the scutellum visible and sometimes large, the elytra not costulate; eyes coarsely faceted; mentum moderate, subquadrate, not filling the oral opening or covering the maxillæ. * **Stenosini**

Anterior coxæ contiguous; body slender, depressed, glabrous, the scutellum very minute, rounded, the elytra not costulate, the pronotum and front of the head remarkably excavated; eyes coarsely faceted, wholly dorsal though on the deep sides of the head; mentum transversely lunate, completely filling the semicircular oral cavity, covering the maxillæ, the apex sinuate and exposing the ligula.....**Dacoderini**

21 — Antennæ enlarged distally, received in a deep cephalic groove continued into the propleuræ; mentum moderate, slightly transverse, concave, covering the ligula and to a slight extent, the maxillæ, the sides of the oral opening acute and prominent; maxillary palpi small and slender, the last joint very narrowly oval, obtusely pointed; eyes wholly dorsal and far from the margin of the head, extremely minute; body narrow, elongate, subparallel, convex, the scutellum small but distinct, triangular; pronotum depressed at base..... **Typhlusechini**

Antennæ not enlarged distally, very compact, cylindric, free; mentum moderate, subquadrate, wholly exposing the maxillæ;

maxillary palpi slender, the last joint slender, fusiform and obtusely pointed; eyes similarly coarsely faceted, divided by the sides of the head; body broadly oblong-oval, feebly sculptured, the epipleuræ very wide; scutellum wholly invisible; prothorax as broad as the elytra but attached by a broad exposed peduncle.
*** Platamodini**

22 — Body small, oblong or suboval, the head widest at base, the coarsely faceted eyes divided by the acute sides, the front feebly lobed at each side; mentum moderate, exposing the maxillæ, the antennæ moderate in length, free, slender, the outer four joints broader; elytra oval, not costate, the scutellum minute, triangular; prothorax attached by a broad peduncle; legs rather short.
Batuliini

It is unusual to find such aberrant characters as the median and terminal processes of the anterior tibiæ and the externally grooved mandibles, appearing in almost identically the same form in two such completely dissimilar types as *Cnemodus* and *Erodius*, these facts showing that, notwithstanding the wonderfully varied form of the body and its various parts and organs, all of these genera of the Tentyriinæ with large mentum have a very pronounced bond of affinity. The tribes foreign to our fauna, introduced for comparison and indicated by the asterisk, are substantially those already recognized, except perhaps the Capnisini and Platamodini, the genera *Capnisa* and *Platamodes* being erroneously considered members of the tribe Tentyriini by Heyden, Reitter and Weise. The Stenosini are represented in my cabinet by *Stenosis*, *Eutagenia*, *Dichillus* and *Oogaster* and our *Araeoschizus* cannot be associated with them, disagreeing in many important characters as shown in the table; it is more closely related to *Adelostoma*, but differs greatly in the form and extent of the mentum. The Batuliini are placed last in the series as forming a more natural transition to the Asidinæ of LeConte and Horn, by way of *Ancpsius*.[1]

[1] There are of course a great many other tribes of the Tentyriinæ which cannot be considered at present, such as the Salaxini, having for its type the remarkable South American genus *Salax*, resembling *Opatrum* but related closely to the Trimytini and Epiphysini, related to our Edrotini. The genus *Hylithus* will apparently constitute a tribe very close to the Trimytini, and *Hyperops* another but slightly differentiated from the Gnathosiini. In my own opinion the genus *Himatismus* should constitute a tribe very near but different from the new world Epitragini, by reason of its different facies and more hexagonal mentum. The male in *Himatismus* is distinguished from the female by a very

Tribe Cnemodini.

There is no tribe closely related to the Cnemodini, although by the general form of the body, developed wings, large scutellum, extent and position of the epipleuræ, form of the eyes and approximation of the hind coxæ, it evidently has more affinity with the Eurymetoponini than with any other. We have apparently but one genus as follows:—

Body parallel, convex, fully winged, the head moderate, rounded, the eyes large, prominent coarsely faceted, but slightly emarginated by the acute sides of the front, which are sometimes united with the fine supra-orbital carina a short distance before them; sides strongly arcuate and converging for a short distance to the epistoma, which is slightly advanced, with its sides converging and deeply sinuate, separated from the front by a strongly elevated, medially subinterrupted ridge, its apex bilobed, concealing the labrum, the mandibles bifid at tip, broadly, deeply grooved externally and with a peculiar alate porrect prominence of the upper external edge; mentum hexagonal, its apex feebly deflexed and slightly sinuate; maxillæ with very large flat ciliate and rounded lobes, the palpi with the last joint oval; antennæ very long and slender, the two or three outer joints but little wider, the eleventh pedunculate, oval, narrower and shorter than the tenth, all the joints abruptly enlarged at their distal ends; prothorax narrower than the elytra, narrowed toward base, very feebly margined at the sides, the flanks continuously convex from the pronotum through the propleuræ; scutellum well developed, elongate, narrowly rounded at tip; elytra elongate, parallel, with exposed rounded humeri, not in the least margined at base, the epipleuræ occupying all of the narrowly inflexed sides and becoming effaced or feebly defined toward base; anterior coxæ large, globular, moderately separated, the process rapidly deflexed to the hind margin of the prosternum, strongly and densely pilose, the middle coxæ very narrowly separated or subcontiguous; hind coxæ narrowly separated, transversely rectilinear, the metasternum very long, with fine transverse ante-coxal grooves, the metepisterna wide and only very slightly narrowed posteriorly, with the suture distinct and straight; legs long and rather slender, the anterior tibiæ with an acute everted apical angle and a similar acute external tooth just beyond the middle, the terminal spur stout and distinct; tarsi long and slender, the claws very long, evenly arcuate and gradually pointed ..... **Cnemodus**

The above rather full diagnosis of this singular genus is taken from an undescribed species named *angustus* below, and pre-

remarkable character, not even suggested in any true Epitragid, the prosternum of the male having a tumid central pubescent fovea completely obsolete in the female; the punctures are wholly effaced in the neighborhood of the fovea.

sumably congeneric with *testaceus*, the original type, but of this I cannot be wholly sure at present.

Cnemodus Horn.

As stated above I assume that all of the three species described below are congeneric, though, if the figure of *testaceus* published by Dr. Horn is even approximately correct, it differs widely from the two new ones here made known: —

Elytra shining but densely, aciculately punctured. Yellowish-testaceous; head obtuse, as long as broad, moderately coarsely punctured between and in front of the eyes; prothorax wider than long, convex, the sides broadly rounded, feebly emarginate anteriorly, the angles obtuse, truncate posteriorly, the angles distinct; disk nearly smooth, moderately shining, more coarsely punctured toward the lateral margins; marginal line scarcely distinct, the pronotum almost continuous with the flank; elytra elongate, subparallel, twice as long as the head and prothorax, the humeral angles distinct, obtuse; under surface faintly and sparsely punctured and sparsely clothed with yellowish hairs. Length 8.0 mm.; width 2.75 mm. California (in the vicinity of Fort Yuma).

testaceus Horn

Elytra polished, feebly rugulose, indistinctly, sparsely and muricately punctate laterally; body more slender..... 2

2 — Form very elongate, parallel, convex, polished, glabrous, with a few short erect hairs laterally, pale and uniform brownish-yellow throughout; head oval, wider than long, distinctly narrowed behind the very large prominent eyes, the vertex with a short longitudinal impressed line at the middle, evenly but not closely, rather coarsely and muricately punctate, the occiput impunctate; antennæ fully half as long as the body, the joints subequal in length; prothorax one-half wider than long, widest just before the middle, where the sides are rather strongly, evenly rounded, thence converging and less arcuate to the basal angles, which are not at all blunt and minutely prominent, less converging but rounded anteriorly to the obtuse apical angles, the apex broadly sinuato-truncate, much wider than the base, the latter coarsely beaded and rectilinearly truncate; surface very convex, polished and perfectly smooth, becoming slightly alutaceous and with some sparse shallow punctures near the sides; elytra about twice as long as the head and prothorax and a fifth wider than the latter, with feebly impressed longitudinal lines toward the suture; under surface feebly punctate, the propleuræ and abdomen nearly smooth. Length 6.3 mm.; width 2.1 mm. Arizona (Mesa).

angustus n. sp.

Form nearly similar but much smaller, pale brownish-yellow the elytra subhyaline and straw-yellow; head small, slightly trans-

verse, inserted to the large prominent eyes, the supra-orbital carina not joining the lateral margin as it does in *angustus*, opaque, sparsely, very obscurely, tuberculately punctate throughout, the vertex very feebly impressed along the median line; antennæ very slender and similar but shorter, not two-fifths as long as the body; prothorax more transverse, nearly three-fourths wider than long, widest at the middle, the sides evenly and strongly arcuate, equally converging toward apex and base which are subequal in width, the former sinuato-truncate with obtuse angles, the latter rectilinear, finely reflexed and beaded, with the angles very obtuse; surface strongly convex, opaque and strongly microreticulate throughout but not definitely punctate; elytra proportioned nearly as in *angustus* but only about a sixth wider than the prothorax, similarly parallel and straight at the sides, the apex rather abruptly ogival, the surface polished, not reticulate, without impressed lines except one at each side of the suture which is very feeble, the surface feebly subrugose, finely, sparsely and muricately though very indistinctly punctured at the sides only; under surface nearly as in *angustus* but duller in lustre. Length 4.8 mm.; width 1.68 mm. Utah (southwestern),—C. J. Weidt.

subhyalinus n. sp.

The species, excepting *angustus*, are very rare and apparently represented by uniques at the present time. In the published figure of *testaceus*, the elytra are relatively very much broader than in either *angustus* or *subhyalinus;* the above description is a transcription of the original.

Tribe Eurymetoponini.

This tribe has been known hitherto under the name Thinobatini, with the Chilean *Thinobatis* Esch., as the representative type. The published characters of that genus do not, however, seem to harmonize sufficiently with our American and Mexican species to be properly included with them, it being stated by Lacordaire that the scutellum is scarcely visible, and inferentially, that the elytra are rather inflexed beneath, with narrow epipleuræ; the figure given by Solier shows also a different form of prothorax and prominent truncate epistoma. It would appear, therefore, that our numerous species extending from Utah to southern Mexico, which hold together in very homogeneous fashion, having the scutellum invariably well developed and the elytra not inflexed beyond the rather wide entire epipleuræ, should constitute a distinctly limited tribe to be designated as above.

The genus *Eurymetopon* Esch., has apparently been misconceived hitherto. Its type was named *rufipes* by Eschscholtz, and said by that author to be from California, — I believe without further indication of locality. Mannerheim, in subsequently describing the species, gave a series of characters that undoubtedly belong to the genus that we have been calling *Eurymetopon*, but stated that it occurs near San Francisco, which is presumably an error, no example of the forms with everted tibial angle being known from above the latitude of Santa Barbara or thereabouts, they being confined to the Sonoran fauna in California. Whence Mannerheim obtained his assumed representative of *rufipes* is uncertain, and the description is not sufficiently definite for identification, but I will regard it as identical with the species subsequently described under the specific name *enorme* by LeConte. We have therefore to fall back upon the description of Lacordaire, which he states is founded upon the species named *rufipes* by Eschscholtz and represented before him, in all probability, by the original type. This description does not fit any genus of the tribe known to me, departing radically in the absence of the extremely constant supra-orbital carina and in antennal structure, as shown in the table below, from what we have become accustomed to know by the name *Eurymetopon*, as identified from a supposed typical example sent to LeConte and alluded to by Horn in his monograph of the Tenebrionidæ. It is rather more than probable that the latter specimen was not a true representative of the species, the mistake being due no doubt to hasty and careless identification. Where Eschscholtz really obtained his type of *rufipes*, which apparently belongs rightfully to the present tribe because of the distinct scutellum and certain other characters mentioned by Lacordaire, is not known, but it was certainly from the southern part of the state or Lower California, if not Mexican, and must have been from the immediate coast regions, as the interior of the country had not then been explored. The supposed duplicate of the original type of *rufipes*, just stated to have been sent to LeConte, proved to be identical with a species from the Colorado Desert of California, previously named *enorme* by that author, showing that it had been collected in that region and

not near the coast, as the species are well known to be very local in distribution; this seems to be an additional reason for doubting the authenticity of the cotype referred to by Horn. I am therefore forced to give our species hitherto known as *Eurymetopon* another generic name.

The case of *Emmenastus* Mots., is still more unsatisfactory. The original description is very short, stating that the body is oval and narrowed in front and behind, having the facies of *Gnathosia* and *Zophosis*,—which hardly resemble each other in any way,—and that the last joint of the palpi is elliptical and feebly truncate at tip. It has for its type a species named *compactus*, said to be a native of Kamtschatka, having the size of *Gnathosia depressicornis* but stouter, and is therefore a comparatively large species, probably some 10 mm. in length. It is black and opaque, with the elytra striate as in *Penthicus* and *Melanestes*,—which is the substance of the entire description. The other species placed in the genus, named *rugosus*, is smaller and is said to be from Sitka. No species of the present tribe is known to me from above the latitude of southern Idaho. Having these facts in mind I am quite unable to comprehend the remark of Dr. Horn on page 269 of his Monograph, that, "while rejecting the typical species to the doubtful list, the genus must be retained, an illustration of the prediction of a genus by an author who at the same time commits a specific blunder in doing it." The latter author assumes moreover that *rugosus* is the type of the genus, while *compactus* was evidently the species so intended by Motschulsky. I therefore definitely reject the genus *Emmenastus* as a component part of our fauna, although it may be a valid Asiatic genus belonging to another tribe. The genera of Eurymetoponini are numerous and those represented in my cabinet may be defined as follows:—

Anterior tibiæ produced externally at tip.....2

Anterior tibiæ not externally prolonged at tip 5

2 — Eyes small, subentire; head without supra-ocular carina, the epistoma broadly, sinuously emarginate; antennæ not extending to the base of the prothorax, the joints 4–10 feebly increasing in thickness, the eleventh larger than the tenth, oval; scutellum distinct, quadrangular; elytra broader than the prothorax; first joint of the

hind tarsi as long as the fourth; body depressed, parallel, the elytra rugose and feebly sulcate. [Type *E. rufipes* Esch.]. **Eurymetopon**

Eyes large, more or less prominent, subentire; head with a distinct supra-orbital carina, curving outwardly before the eyes; epistoma never emarginate, truncate or arcuato-truncate; mandibles ridged externally above; antennæ slender, extending about to the base of the prothorax, cylindric, the four last joints broader, compressed, forming a loose club, the eleventh as long as the tenth or longer but always distinctly narrower, more or less pointed; scutellum distinct, transverse or quadrangular; elytra never strongly rugose and nearly always having distinct serial punctures, the series wholly unimpressed as a rule.....3

3 — Tarsi beneath with numerous long stiff setæ, the basal joint of the posterior shorter than the fourth; front broadly truncate or sinuato-truncate, even, not biemarginate; hind wings well developed to vestigial or obsolete; prothorax generally fully as wide as the elytra, sometimes very slightly narrower. [Type *Eurymetopon abnorme* Lec.]..... .....**Metoponium**

Tarsi with very few short sparse spiniform setæ beneath, the basal joint of the posterior longer than the fourth; frontal margin evidently, though minutely, biemarginate; sculpture finer as a rule, the lustre more generally subopaque, though frequently polished; prothorax generally very distinctly narrower than the elytra.....4

4 — Body elongate, with fully developed wings; prothorax more nearly parallel, with rounded sides and acute basal angles as in the preceding genus; basal joint of the hind tarsi much longer than the fourth; scutellum well developed, nearly uniform, angulate and but slightly transverse. [Type *T. longipennis* Csy.]. **Telabis**

Body broadly oval, without wings, the prothorax narrowing from base to apex, with very obtuse basal angles; scutellum small; front broadly, feebly trilobed. [Type *C. inflatus* Lec.] ...**Cryptadius**

5 — Antennæ long and very slender, nearly as in the preceding group; eyes large, subentire or not deeply emarginate and more or less prominent..... 6

Antennæ shorter and rather stout, though of the same general organization, the eighth joint never elongate; eyes rather small, transverse, not prominent, about half divided by the lateral canthus of the head.....13

6 — Body elongate, parallel..... 7

Body oval, convex, glabrous, devoid of hind wings; tarsi spinulose or sparsely and very coarsely setose beneath..... 12

7 — Surface glabrous..... ...8

Surface pubescent 11

8 — Tarsi pubescent beneath 9

Tarsi with sparse stiff subspiniform setæ beneath..... 10

9 — Frontal margin evenly and broadly arcuato-truncate, without emarginations; wings apparently wanting or vestigial; elytra feebly and briefly carinulate at each side of the suture near the tip. [Type *Emmenastus punctatus* Lec.].....**Emmenides**

Frontal margin feebly and angularly produced in the middle; wings very fully developed; elytral series entire and conspicuous. [Type *Emmenastus texanus* Lec.].....**Armalia**

10 — Frontal margin somewhat variable, evenly sinuato-, or arcuato-truncate, the epistoma sometimes very feebly produced and broadly truncate; wings fully developed to decidedly abbreviated. [Type *Emmenastus longulus* Lec.].....**Hylocrinus**

11 — Head very short and broad, the apical margin rectilinearly transverse and even; tarsi with stiff yellow setiform hairs beneath; wings apparently somewhat abbreviated or perhaps vestigial; pronotum not foveate, the elytra margined at base as usual. [Type *E. cribratus* Horn].....**Emmenastrichus**

Head less transverse, the frontal margin very broadly arcuate from above; tarsi with numerous short decumbent stiff yellow subspiniform hairs beneath; wings as in *Hylocrinus;* pronotum with two deep fossæ at base, the elytra not margined at base; first joint of the hind tarsi much elongated. [Type *Emmenastus foveicollis* Champ.].....*Ditaphronotus

12 — Tibiæ normal, subcylindric, the anterior nearly straight as usual; frontal margin generally feebly sinuato-truncate, not evidently biemarginate. [Type *Emmenastus conicicollis* Csy.].**Steriphanus**

Tibiæ gradually enlarged to the tip, the anterior short and arcuate; frontal margin broadly arcuato-truncate, with two very minute feeble emarginations; basal joint of the hind tarsi longer than the fourth; prothorax narrowing from base to apex as in *Cryptadius.* [Type *Emmenastus pinguis* Lec.].....**Stictodera**

13 — Frontal margin broadly arcuato-truncate, entire; hind wings very small and vestigial; tarsi sparsely spinulose beneath, the basal joint of the posterior longer than the fourth; right mandible with a small acute tooth on the upper surface; body elongate, parallel to suboval, the integuments dense. [Type *Emmenastus ater* Lec.].....**Melanastus**

The characters given above for *Eurymetopon* Esch., are those published by Lacordaire in the "Genera," as before intimated. The genus is not known to me.

Metoponium n. gen.

This is the genus that is known in our lists under the name *Eurymetopon* Esch., and was so designated by the writer in his

former essay on the present group (Ann. N. Y. Acad. Sci., V, p. 330). The species are extremely numerous, closely allied and local, forming a very difficult study. Doubtless many more than a hundred of them exist in the arid regions extending from western Texas to southern California, this region, expanding but little to the north or south, being the sole and comparatively restricted habitat of the genus. The forms enumerated below seem to be specific, but further study may prove some of them to be more properly subspecies. They are differentiated principally by the form of the body and development of the hind wings, after the manner of *Blapstinus* inhabiting the same environments, by sculpture, size and form of the prothorax, and, in some cases, by certain evident differences in the scutellum. Those in my cabinet may be defined as follows:—

Anterior tibiæ strongly and acutely everted externally at apex, as usual in the first division of the tribe; elytral punctures feebly setigerous, the setæ erect; antennæ long; surface generally shining, at least in part; wings fully developed to vestigial.....2

Anterior tibiæ swollen and rounded externally at apex but not angularly produced; elytral punctures nude; antennæ shorter; hind wings apparently obsolete; integuments dull. [Subgen. *Metoponiopsis* n. subg.].....39

2 — Metasternum long, on a line through the coxæ, between the mesocoxæ and ante-metacoxal groove, very much longer than the first ventral segment.....3

Metasternum shorter, only slightly longer than the first segment, the wings somewhat less developed than in the preceding group....23

Metasternum still shorter, as nearly as discernible equal in length to the first segment; body more oval as a rule, the wings much abbreviated or vestigial.....30

3 — Prothorax equal or subequal in width to the elytra.....4

Prothorax very evidently narrower than the elytra in both sexes.....20

4 — Prothorax subparallel, widest at about the middle.....5

Prothorax widest evidently behind the middle, more notably narrowed anteriorly.....17

5 — Body more or less stout in form.....6

Body elongate and notably slender.....16

6 — Prothorax always very obviously less than twice as wide as long..7

Prothorax shorter and strongly transverse, twice as wide as long or very nearly.....15

7 — Species of larger size.....8

Species of moderate size.....10

8 — Prothorax greatly developed, slightly wider than the elytra. Body parallel, convex, polished, piceous-black, with dark rufous legs and antennæ; head barely half as wide as the prothorax, the sides only moderately converging and arcuate, not quite parallel at the eyes, the front broadly truncate, the surface closely, coarsely and evenly punctato-cribrate, with a small and very uneven occipital impunctate spot; prothorax large, three-fourths wider than long, the sides moderately arcuate, becoming more convergent near the apex, the basal angles obtuse, not at all prominent or rounded, the punctures moderately coarse, impressed and separated by about twice their own diameters, becoming slightly coarser, dense and confluent, forming long rugæ, in about lateral sixth, except near the reflexed lateral edges; scutellum well developed, transverse, finely punctate; elytra two-thirds longer than wide, barely three times as long as the prothorax, rapidly and obtusely ogival at tip, rather strongly, moderately closely and confusedly punctate except toward the sides, where the punctures are in close-set irregular series, coarser and evidently muricate; abdomen not coarsely but somewhat strongly and closely punctured medially, more coarsely laterally as usual. Length 8.0 mm.; width 3.2 mm. Arizona (near Yuma).....**laticolle** n. sp.

Prothorax fully equal in width to the elytra but not wider in either sex.....9

9 — Form stout, parallel, convex, shining, black or piceous-black, with red legs and antennæ; head moderate, though a little more than half as wide as the prothorax in the male, less broadly truncate than in *laticolle*, with the sides strongly converging and evenly arcuate before the eyes, the punctures coarse, dense, more uneven and subconfluent, the occipital spot small but better defined; prothorax large, two-thirds wider than long, the sides moderately arcuate, rounding and converging but little more anteriorly, the basal angles right and very slightly prominent, the punctures moderately small and well separated, becoming rather gradually coarse, dense and longitudinally confluent but not forming long or well-defined rugæ laterally; scutellum moderate, transverse, punctured toward base; elytra nearly as in *laticolle*, the punctures small but distinct, confused suturally but close-set and coarse in moderately regular series throughout laterally, where the intervals are unevenly uniseriate with more widely spaced punctures, the series very feebly impressed toward the suture; abdomen finely, sparsely punctate medially, more coarsely on the basal segment. Length 7.2–8.4 mm.; width 2.8–3.4 mm. California (Colorado Desert).....**abnorme** Lec.

Form less stout than in *abnorme*, elongate, parallel, strongly convex, shining, dark blackish-castaneous, the under surface piceous, the legs and antennæ dark red; head broadly truncate, the sides only moderately converging before the eyes and arcuate, the angles evident though broadly rounded, the punctures less coarse than

in *abnorme*, close-set, the occipital spot rather large and ill-defined; prothorax large, nearly as in *abnorme* but less coarsely punctured throughout, the punctures similarly arranged, the basal angles rather more than right, not rounded but not at all prominent; scutellum well developed, transverse, finely punctured almost throughout; elytra nearly as in *abnorme* but narrower, similarly but much more finely punctured throughout; abdomen finely, sparsely punctured medially, only a little less finely on the basal segment. Length 7.5 mm.; width 3.0 mm. California (Needles).....**faustum** n. sp.

Form stout, parallel, convex, polished, rufous in color throughout, sometimes nearly black; head large, nearly three-fifths as wide as the prothorax, broadly truncate, the sides only moderately converging but strongly arcuate before the eyes, the punctures coarse, somewhat irregular, close-set but not very dense, the occipital spot well defined: prothorax large, three-fourths wider than long, the sides moderately rounded, more converging near the apex, the basal angles slightly obtuse, not rounded but not prominent, the punctures rather small medially and notably sparse, becoming gradually very coarse, dense and partially confluent laterally; scutellum moderate, punctured; elytra three-fifths longer than wide, parallel and nearly straight at the sides, abruptly and obtusely, ogivally rounded at apex in posterior fifth, with very sparse but widely impressed and distinct punctures suturally, becoming very coarse and rather close-set in regular series laterally, the lateral punctures scarcely at all muricate, the very feebly defined series toward the suture somewhat impressed; abdomen finely, sparsely punctured medially. Length 7.8–8.8 mm.; width 3.25–3.4 mm. Arizona (Nogales), — H. F. Wickham.
candidum n. sp.

Form moderately stout, parallel, polished, rufous in color throughout; head coarsely and closely, somewhat irregularly punctato-cribrate, the punctures generally somewhat separated, the occipital oval spot well defined; apex broadly truncate, the sides strongly converging and moderately arcuate before the eyes; prothorax large, more transverse than in *candidum*, nearly four-fifths wider than long, the sides moderately arcuate, more strongly converging near the apex, the basal angles right, not at all rounded but scarcely prominent, the punctures rather coarsely impressed and well separated medially, becoming rather rapidly very coarse, dense and distinctly confluent in about lateral fifth; scutellum well developed, transverse, punctured anteriorly; elytra fully two-thirds longer than wide, abruptly and obtusely, ogivally rounded at tip, more than three times as long as the prothorax, the punctures in irregular series throughout the width, fine and sparse suturally, coarse, more close-set and asperulate in more regular series laterally, the series toward the suture scarcely at all impressed; abdomen polished though slightly rugulose, rather finely but strongly, sparsely punctured medially, evidently more coarsely

on the basal segment. Length 6.7–8.0 mm.; width 2.7–3.27 mm. Arizona (San Bernardino Ranch, Cochise Co.), — F. H. Snow. **pallescens** n. sp.

10 — Femora rather coarsely punctured, especially toward base.....11

Femora finely, sparsely punctured.....12

11 — Body stout, oblong, very convex, parallel, shining, blackish-castaneous, the under surface, legs and antennæ concolorous and dark piceo-rufous; head rather large, especially in the male, much more than half as wide as the prothorax, broadly truncate, the sides moderately converging, strongly arcuate, the punctures coarse, deep, close-set, somewhat irregular, the occipital spot clearly limited; prothorax large, two-thirds wider than long, a little more transverse in the female, the sides evenly and rather strongly arcuate, the basal angles obtuse, neither rounded nor prominent, the punctures rather coarse, perforate and somewhat close-set, becoming gradually but little coarser but dense, coalescent and forming long rugæ laterally; scutellum moderate, transverse, finely punctate; elytra about one-half longer than wide, even shorter in the female, distinctly less than three times as long as the prothorax, obtusely ogival at tip, with series of small and close-set punctures throughout, becoming but little larger at the sides, the punctures of the intervals equally fine but sparse and confused suturally, becoming very unevenly uniserial, less close-set and much larger than those of the principal series laterally, the series near the suture finely and barely visibly impressed; abdomen moderately finely, very strongly and rather closely punctate medially. Length 6.8 mm.; width 2.9–3.1 mm. New Mexico (Deming), — H. F. Wickham.....**congruens** n. sp.

Body much less stout, strongly convex, polished, deep black in color, the legs and antennæ rufo-piceous; head rather large, almost three-fifths as wide as the prothorax in the male and but little narrower in the female, broadly truncate, the sides only moderately converging but strongly arcuate, the surface with a small impression in front of the occipital impunctate spot, the punctures coarse, deep and dense; prothorax as wide as the elytra and two-thirds wider than long in the male, a little shorter and slightly narrower than the elytra in the female, the sides moderately arcuate, more converging and becoming feebly sinuate toward apex, the basal angles right and evidently prominent, the punctures coarse, perforate and close-set, becoming gradually but little larger but dense and coalescent laterally; scutellum rather small, transverse; elytra one-half longer than wide, a little shorter in the female and sometimes with slightly arcuate sides, the apex obtusely ogival-punctures close-set in rather even, suturally impressed series, fine but strong near the suture, coarse laterally, the interstitial punctures strong but sparse and confused suturally, becoming more remote in single series and larger than the serial punctures laterally; abdomen finely but strongly, rather closely punctate medially,

a little more coarsely but more sparsely on the first segment. Length 6.2–7.6 mm.; width 2.6–3.0 mm. Arizona (near the southern boundary), — Morrison. ..... **perforatum** Csy.

12 — Form strongly convex as in *congruens* and *perforatum* 13

Form very moderately convex 14

13 — Form and habitus nearly as in *perforatum*, with smaller head, less prominent basal angles of the prothorax and somewhat stouter form, very convex, black, polished, the legs, antennæ and under surface dark rufous to piceous; head but little more than half as wide as the prothorax in either sex, nearly as in *perforatum*, but with the feebly converging sides before the eyes more arcuate; prothorax fully three-fourths wider than long in both sexes, nearly as in *perforatum* but with the coarse punctures generally sparser, becoming rather more rapidly dense and coalescent near the sides; scutellum similar, moderate in size, punctured; elytra nearly similar but rather shorter, with somewhat more arcuate sides, about three times as long as the prothorax; abdomen rather finely but strongly, moderately closely and equally punctured medially through the first three segments. Length 6.8–7.2 mm.; width 2.7–3.1 mm. New Mexico (Deming), — H. F. Wickham.
anceps n. sp.

Form nearly as in the two preceding species but slightly less convex and with a narrower prothorax, shining, dark piceous, the legs and antennæ dark rufous; head well developed, three-fifths as wide as the prothorax, broadly truncate, the sides rather strongly converging and evenly arcuate before the eyes, with the angles broadly rounded but somewhat evident, the punctures coarse but smaller than in the two preceding species, unevenly close-set, the occipital spot large though ill-defined; prothorax rather more than two-thirds wider than long, the sides evenly and rather strongly arcuate, rather more converging and straight anteriorly, the basal angles obtuse and not prominent, the punctures not very coarse but strong and very sparse medially, becoming gradually much coarser, dense and subcoalescent laterally; scutellum rather small; elytra one-half longer than wide, not quite three times as long as the prothorax, but slightly, though evidently, wider in the male, the sides parallel and nearly straight, the apex obtusely ogival, the punctures very coarse and serial laterally, the inner series feeble, the interstitial punctures uniserial throughout except on the sutural interval; abdomen finely, sparsely punctured medially. Length 7.0 mm.; width 2.9 mm. Arizona ..... **arizonicum** n. sp.

14 — Form oblong, parallel, much less convex than the preceding species, shining, dark piceous, the under surface, legs and antennæ rufous; head moderate, though evidently more than half as wide as the prothorax in the male, the punctures coarse and unevenly close-set, the occipital spot small and well defined, the sides converging and strongly arcuate before the eyes, wholly obliterating the angles; prothorax large, rather more than two-thirds wider than

long, fully as wide as the elytra in the male, the sides evenly and moderately arcuate, the basal angles obtuse, not at all rounded or prominent, the punctures rather small and sparse but strong, becoming rapidly much coarser, dense and longitudinally rugose in almost lateral fourth, again becoming less rugose along the reflexed margins as generally the case; scutellum rather small, transverse, constricted at base; elytra one-half longer than wide, three times as long as the prothorax, ogivally obtuse in nearly apical third, the punctures close-set in unimpressed series, small suturally, only moderately coarse laterally, the interstitial punctures unevenly uniserial except suturally; abdomen distinctly, rather sparsely punctured medially, unusually coarsely so on the first segment; inferior emargination of the genital segment angular. Length 7.2 mm.; width 2.8 mm. Arizona (probably near Yuma) .....**socium** n. sp.

Form nearly as in *socium* and similar in coloration and in its moderate convexity; head in the male nearly as in *socium* but with the angles less obliterated and the punctures decidedly smaller, more evenly distributed, very close-set but not crowded, the occipital spot very well defined; prothorax in the male much shorter and more transverse, fully four-fifths wider than long, otherwise as in *socium*, the punctures rather less sparse medially and less coarse laterally; scutellum a little larger; elytra similar in dimensions but more abruptly, obtusely ogival in but slightly more than apical fourth, slightly more than three times as long as the prothorax and equal in width, the punctures disposed as in *socium* but smaller throughout and more strongly muricate laterally, very fine, sparse and feeble suturally; abdomen minutely, sparsely punctured medially, but little less finely on the first segment, the inferior apical emargination of the genital segment broadly parabolic. Length 6.7 mm.; width 2.5 mm. Arizona (probably Gila valley).....**subsimile** n. sp.

15 — Body oblong, only moderately convex, polished, black or piceous-black, the legs and antennæ dark rufous; head short and transverse, small, not distinctly more than half as wide as the prothorax, the portion before the eyes unusually short, barely twice as long as the eyes, truncate, the sides strongly converging and arcuate, the angles somewhat evident, the punctures coarse, unevenly close-set, the occipital spot rather large and well defined; prothorax scarcely visibly less than twice as wide as long, the sides moderately arcuate, the basal angles rather more than right, not prominent, the punctures rather strong, well separated, becoming rapidly coarse, dense and subconfluent laterally; scutellum rather small, feebly punctured basally; elytra parallel, with nearly straight sides, somewhat more than one-half longer than wide, three and one-half times as long as the prothorax and very slightly wider, the apex obtusely ogival; punctures not very close-set in almost even series, fine suturally, coarse and somewhat muricate laterally, the intervals uniseriately and more loosely

punctate, the sutural interval alone with confused punctures; abdomen medially and femora minutely, sparsely punctured throughout. Length 7.7 mm.; width 3.0 mm. Arizona.
parvuliceps n. sp.

Body more broadly oblong and still less convex, more depressed than in almost any other species, dark rufo-piceous, the legs and antennæ paler, polished; head moderate, but little more than half as wide as the prothorax, the sides much less converging than usual, arcuate, becoming parallel toward the eyes, the apex truncate, the punctures only moderately coarse, dense, confluent toward the eyes, the occipital spot small, sometimes almost wanting; prothorax but very slightly less than twice as wide as long, the sides moderately arcuate, more converging apically, the basal angles nearly right, not at all prominent, the punctures rather small but deep, moderately separated, becoming very gradually but moderately coarse and dense and forming long rugæ laterally; scutellum rather well developed, transverse, sparsely punctured; elytra as in *parvuliceps*, more than three times as long as the prothorax but not wider, the punctures smaller throughout, especially toward the sides and more irregularly disposed suturally; abdomen finely, sparsely and evenly punctured medially through the first three segments. Length 6.9–7.2 mm.; width 3.18–3.22 mm. Arizona..... .....**rufopiceum** n. sp.

Body relatively shorter, stouter, more oblong and rather more convex, shining, piceous-black, the under surface dark, the legs and antennæ pale, rufous; head well developed, almost three-fifths as wide as the prothorax, coarsely, not very densely punctate; prothorax twice as wide as long, a little less in the male, the sides evenly and unusually strongly rounded, the basal angles very obtuse, not rounded or prominent, the punctures not coarse but strong, well separated, becoming rapidly very coarse, dense and subconfluent in almost lateral fourth; scutellum well developed, transverse, punctured except apically; elytra not quite one-half longer than wide, about three times as long as the prothorax and scarcely perceptibly wider, very rapidly and obtusely ogival at apex, the punctures rather close-set in somewhat irregular series, moderately small and strong suturally, coarse and muricate laterally, the interstitial punctures sparse and broadly confused suturally, irregularly serial laterally, the subsutural series scarcely at all impressed; abdomen not very coarsely but unusually strongly, conspicuously, moderately loosely and evenly punctured medially, somewhat more coarsely on the basal segment; femora minutely, sparsely punctured. Length 7.2–7.75 mm.; width 3.28–3.35 mm. Texas (El Paso)...**saginatum** n. sp.

16 — Form parallel, moderately slender and not very convex, polished, black with feeble piceous tinge, the legs and antennæ rufous; head nearly three-fifths as wide as the prothorax, truncate, the sides moderately convergent and very strongly arcuate, becoming

parallel toward the eyes, the punctures very coarse, deep and close-set, the occipital spot feeble; prothorax fully three-fourths wider than long, the sides evenly, rather strongly arcuate, but little more converging anteriorly, the basal angles obtuse, not rounded or prominent, the punctures coarse, perforate, unevenly distributed but generally rather close-set, becoming rather abruptly still coarser, dense and subconfluent in lateral fifth or sixth; scutellum moderate, transverse; elytra three-fifths longer than wide, as wide as the prothorax and about three and one-half times as long, rather gradually and not very obtusely ogival behind, the punctures rather small but strong, sparse and for the most part confused toward the suture, coarse, muricate and close-set in series laterally, the interstitial punctures subequal to the serial, more widely spaced in tolerably regular single series except toward the suture; abdomen finely rugulose, finely but strongly, moderately sparsely punctured medially. Length 7.2 mm.; width 2.75 mm. Arizona (southern), — Morrison.

carbonatum Csy.

Form more slender, elongate, parallel, moderately convex, polished, deep black, the legs and antennæ rufous; head well developed, moderately coarsely, regularly and not very densely punctate, the occipital spot large but ill-defined, the sides moderately converging and strongly arcuate but not quite becoming parallel near the eyes; prothorax three-fifths wider than long, the sides moderately arcuate, becoming more strongly convergent and nearly straight at apex, the basal angles obtuse, not rounded but not at all prominent, the punctures not notably coarse but deep and sparse medially, becoming rather rapidly coarse, dense and subcoalescent in about lateral fifth; scutellum moderate, punctate at base; elytra fully two-thirds longer than wide, barely perceptibly wider than the prothorax and a little more than three times as long, gradually parabolic at tip, the punctures moderately close-set in rather regular series throughout, fine suturally, moderately coarse laterally, the interstitial punctures similar, forming single series, confused only on the sutural interval; abdomen feebly rugulose, minutely, sparsely punctate medially. Length 7.0 mm.; width 2.5 mm. Arizona (Phœnix).

procerum n. sp.

Form very slender as in *procerum* and similar in lustre and coloration; head relatively somewhat larger, between three-fifths and two-thirds as wide as the prothorax, the sides less converging and still more strongly arcuate, becoming almost parallel toward the eyes, the punctures deeper, rather coarse, separated generally by their own widths, the occipital smooth space obsolete and occupied by sparser punctures; prothorax much shorter, nearly three-fourths wider than long, the sides moderately arcuate, becoming more convergent and subsinuate anteriorly, the basal angles nearly right and minutely prominent, the punctures fine and rather sparse medially, much finer than in *procerum*, becom-

ing abruptly very coarse and close-set but not contiguous in about lateral fifth; scutellum larger, rather well developed; elytra not quite so elongate, barely three-fifths longer than wide and gradually more angular and ogival at apex, scarcely wider than the prothorax and three and one-half times as long, almost similarly punctate; abdomen nearly smooth, finely, sparsely punctate medially. Length 7.2 mm.; width 2.5 mm. Arizona (locality unrecorded).....**prolixum** n. sp.

Form very slender, much smaller in size, more convex and subcylindrical, generally shining, piceous-black, sometimes paler anteriorly and beneath, the legs and antennæ rufous; head relatively large, more than three-fifths as wide as the prothorax, coarsely, unevenly punctate, with a feeble impression before the occipital smooth spot, the sides moderately converging and strongly arcuate; prothorax two-thirds wider than long, the sides evenly and strongly arcuate, more converging and subsinuate anteriorly, the basal angles obtuse, not at all blunt or prominent, the punctures rather coarse and sparse medially, becoming somewhat abruptly much coarser, dense and coalescent near the sides; scutellum rather small, punctate; elytra one-half to three-fifths longer than wide, somewhat abruptly and very bluntly ogival at apex, about as wide as the prothorax and three to three and one-half times as long, probably according to sex, rather strongly but not very closely punctate even laterally, where the punctures are coarse and serial, largely confused toward the suture, the surface normally polished but sometimes dull because of stronger microreticulation (*sculptile*); abdomen rather strongly and sparsely punctured medially. Length 4.8–6.0 mm.; width 2.1–2.27 mm. Arizona (near the southern boundary), Morrison [= *sculptile* Csy.].....**papagonum** Csy.

17 — Body only moderately convex, less stout and smaller in size...18

Body large, stout and rather strongly convex 19

18 — Form oblong, dark rufo-piceous, the legs and antennæ paler rufous, shining; head moderate, a little more than half as wide as the prothorax, not very coarsely but closely punctate, the occipital smooth spot well defined, the sides moderately convergent and strongly arcuate, becoming nearly parallel toward the eyes; prothorax three-fourths wider than long, the sides subevenly and distinctly arcuate, the basal angles obtuse, not blunt but not at all prominent, the disk widest slightly behind the middle, rather finely but strongly, only moderately sparsely punctate, becoming rapidly somewhat coarsely, very densely and coalescently so in about lateral fifth; scutellum moderate, transverse, punctulate; elytra one-half or slightly more, longer than wide, rather gradually ogival behind in nearly apical third, as wide as the prothorax and a little more than three times as long, the punctures small and sparse but strong and largely confused near the suture, coarse and alternately closer or more widely spaced in series laterally; abdomen minutely, sparsely punctured medially. Length 6.0–6.5 mm.; width 2.4–2.7 mm. Arizona.....**fusculum** Csy.

Form elongate, parallel, shining, piceous-black, the legs and antennæ rufous; head short and transverse, broadly truncate at apex, evidently more than half as wide as the prothorax, the sides very feebly converging and strongly arcuate, becoming parallel toward the eyes, the punctures coarse, close-set, the occipital spot well defined; prothorax rather more than three-fourths wider than long, widest near basal third, the sides evenly and distinctly arcuate, the basal angles as in *fusculum;* disk with moderately small, deeply impressed, not very sparse punctures, abruptly but only moderately coarse, dense and forming rugæ in lateral fifth; scutellum well developed, transverse, punctulate; elytra formed as in *fusculum*, but more elongate, two-thirds longer than wide, as wide as the prothorax and almost four times as long, the punctures rather sparse but strong, close-set in series throughout, coarse laterally, the interstitial punctures less close-set in single series except on the first and second intervals; abdomen minutely and sparsely punctured medially. Length 7.7 mm.; width 3.0 mm. Arizona (probably near Yuma).

truncaticeps n. sp.

19 — Body elongate, parallel, very large in size, shining, black, the legs and antennæ piceo-rufous; head well developed, opaque, not very coarsely or deeply, regularly punctato-cribrate, the punctures separated by their own widths, the occipital spot small but well defined, the sides moderately arcuate and converging, with the angles somewhat obvious though broadly rounded; prothorax large, nearly three-fourths wider than long, widest slightly behind the middle, the sides moderately arcuate, strongly converging and becoming straight anteriorly, the basal angles right and notably prominent, the sides before them being sinuate for a short distance; disk coarsely, deeply and somewhat closely punctate, gradually very coarsely and densely so laterally; scutellum moderate, transverse, strongly and densely punctate; elytra three-fifths longer than wide, as wide as the prothorax and three and one-half times as long, rapidly and obtusely ogival at apex, rugose by oblique light throughout, strongly but sparsely, in great part confusedly punctured suturally, very coarsely and closely in series laterally; abdomen feebly rugulose, rather finely but strongly, not closely punctate medially, more coarsely on the basal segment. Length 8.7–9.0 mm.; width 3.5–3.75 mm. Arizona (Nogales), — H. F. Wickham.....**crassum** n. sp.

Body more oblong-suboval, shining, dark castaneous, the under surface, legs and antennæ rufous; head well developed, subopaque, not very coarsely but deeply, subevenly punctate, the punctures separated by their own widths, the occipital spot well defined, rather small, the sides rather strongly converging and moderately arcuate; prothorax large, two-thirds wider than long, widest near basal third, the sides rather strongly arcuate, very converging and becoming straight anteriorly, the basal angles obtuse, not blunt but not at all prominent; disk strongly though only moderately

coarsely and rather closely punctured, becoming gradually moderately coarsely, very densely and coalescently so laterally; scutellum moderate, punctate in basal half; elytra one-half longer than wide, very slightly wider than the prothorax and barely three times as long, obtusely and ogivally rounded behind in nearly apical third, the sides very feebly arcuate, the punctures coarse, strongly muricate and forming close-set series laterally, smaller but still strong and confused near the suture; abdomen minutely, sparsely and very inconspicuously punctured medially. Length 8.0 mm.; width 3.5 mm. California (Colorado Desert).

egregium n. sp.

20 — Body stout in form, of large size..... 21

Body more elongate and smaller in size..... 22

21 — Form broadly oblong-elongate, only moderately convex, shining, piceous-black, the legs and antennæ rufous; head well developed, much more than half as wide as the prothorax, the sides moderately converging and arcuate, the frontal margin broadly and distinctly sinuate, the punctures rather small but perforate, separated by nearly twice their own widths on the vertex, the occipital smooth spot rounded and sharply defined; prothorax short, four-fifths wider than long, the sides parallel, subevenly and distinctly arcuate, the basal angles obtuse, not blunt or at all prominent, the punctures rather small but strong and sparse near the middle, gradually becoming very coarse and finally dense but not very coalescent laterally; scutellum moderate, transverse; elytra three-fifths longer than wide, not quite four times as long as the prothorax and about a fifth wider, obtusely ogival at apex, the sides rounding slightly at base to the humeral angles, the punctures not very close-set in series throughout, moderately small but strong suturally, coarse and muricate laterally, not at all larger or confused above the humeri, the interstitial punctures nearly similar, more widely spaced in single series, confused on the first two intervals; abdomen feebly rugulose, finely but strongly, sparsely punctured medially. Length 9.1 mm.; width 3.5 mm. Arizona (locality unrecorded)... .....**extensum** n. sp.

Form and coloration nearly similar; head subsimilar, except that the frontal margin is evenly and rectilinearly truncate and the punctures very much coarser, shallow and separated by about their own widths, the occipital smooth spot small and ill-defined; prothorax similar, except that the sides are irregularly rounded, more abruptly convergent and straight or subsinuate anteriorly, the disk widest before the middle, the basal angles more nearly right and very feebly prominent, the punctures strong and rather sparse medially, becoming more abruptly very coarse, densely crowded but not very coalescent in about lateral fifth; scutellum moderate; elytra fully two-thirds longer than wide, more obtusely, ogivally rounded at apex, scarcely a sixth wider than the prothorax and not quite four times as long, the sides similarly rounding at base

to the humeral angles, the sculpture nearly as in *extensum*, except that the punctures become much coarser, denser and confused above the humeri for a short distance from the base; abdomen feebly rugulose, finely, sparsely punctate medially. Length 8.0–8.5 mm.; width 3.3–3.4 mm. Arizona (southern), Morrison. **dubium** Csy.

Form rather less elongate and very slightly more convex than in the two preceding species, black, the under surface piceous, the legs and antennæ rufous, polished; head almost three-fifths as wide as the prothorax, rectilinearly and broadly truncate, the sides moderately converging and strongly arcuate, the punctures coarse, deep and very close, generally separated by less than their own widths, the occipital spot more or less small but well defined; prothorax less transverse, three-fourths wider than long, the sides variably but moderately arcuate, the disk widest from behind to somewhat before the middle, the basal angles obtuse, not at all blunt or prominent; punctures rather coarse, deep, moderately sparse, becoming gradually coarse, dense but only slightly confluent in about lateral fourth; scutellum well developed; elytra one-half to slightly more, longer than wide, very obtusely ogival at apex, about a sixth wider than the prothorax and three and one-half times as long, the sides feebly rounding to the humeri basally, the humeri evidently exposed at base, the punctures nearly as in *dubium* but rather less confused, though becoming coarser, above the humeral callus; abdomen finely, moderately sparsely punctured medially. Length 8.2–8.6 mm.; width 3.3–3.5 mm. Arizona (Phœnix) ....**phœnicis** n. sp.

22 — Elongate, rather strongly convex, polished, black to rufous, the legs and antennæ paler, rufous; head moderate, transversely truncate, the sides only feebly converging and moderately arcuate, not becoming quite parallel toward the eyes, the punctures coarse, deep, even, distinctly separated, the occipital smooth spot irregular and ill-defined; prothorax fully three-fourths wider than long, the sides rather strongly arcuate, more converging, straight and with the edge just visibly serrulate anteriorly, the basal angles more or less minutely and feebly prominent; punctures rather coarse, deep, moderately separated, becoming more or less gradually coarse and dense laterally; scutellum moderate; elytra more than one-half to nearly three-fifths longer than wide, evidently wider than the prothorax and about three and one-half times as long, obtusely ogival at tip, the punctures moderately coarse and close-set in series laterally, alternating with the more widely spaced and somewhat larger uniserial punctures of the intervals; abdomen finely, sparsely punctate medially. Length 6.8–7.4 mm.; width 2.9–3.2 mm. Arizona (Nogales), — H. F. Wickham ....**hebes** n. sp.

Elongate and rather less convex, brownish-rufous in color, shining; head rather well developed, truncate, the sides only moderately

converging and strongly arcuate, becoming subparallel near the eyes, the punctures coarse, irregular, more or less dense, the occipital spot uneven and ill-defined; prothorax short, fully four-fifths wider than long, widest from a little behind to before the middle, the sides moderately arcuate, more converging and sometimes straighter anteriorly, the basal angles obtuse, not blunt or prominent, the punctures sparse and moderately coarse, becoming rather rapidly dense and coarser in about lateral fifth; scutellum rather small; elytra a little more than one-half longer than wide, very distinctly wider than the prothorax and about three and one-half times as long, obtusely ogival at tip, the sides rounded toward the humeri, punctured nearly as in *hebes*, the abdomen finely, sparsely punctured medially. Length 6.8–6.9 mm.; width 2.7–2.8 mm. Arizona.....**rufescens** n. sp.

23 — Base of the prothorax rather distinctly narrower than the base of the elytra; scutellum rather well developed, transverse.....24

Base of the prothorax equal in width to the base of the elytra.....25

24 — Form oblong, rather convex, shining, the elytra scarcely at all alutaceous at tip, dark castaneous in color, the legs rufous; head short, strongly but not densely punctate, with a large ill-defined occipital impunctate area, the sides converging and feebly arcuate before the eyes to the broadly rounded angles; prothorax about three-fourths wider than long, widest at the middle, the sides rather strongly, subevenly arcuate, the apex only very slightly narrower than the base; punctures strong but rather sparse, very gradually and slightly coarser, close and longitudinally confluent toward the sides; scutellum polished, with a few fine punctures at base only; elytra rather less than one-half longer than wide, with series of rather coarse punctures toward the sides, the interstitial series similar but rather less approximately punctate; abdomen finely but strongly, somewhat sparsely punctured medially. Length 6.8 mm.; width 3.0 mm. Texas (near El Paso). **congener** Csy.

Form somewhat similar but smaller and less coarsely sculptured, polished, pale testaceous, the abdomen darker except at tip; head relatively rather finely and loosely punctate, without vestige of an impunctate occipital area, the sides before the eyes converging and evenly, strongly arcuate throughout; prothorax smaller than usual, almost twice as wide as long, rather finely, sparsely punctate, becoming somewhat abruptly coarsely and confluently so in about lateral fourth, except close to the margin, where the coarse punctures are simply contiguous, the sides evenly, strongly arcuate, the apex distinctly narrower than the base; scutellum impunctate, polished; elytra one-half longer than wide, with series of moderately coarse punctures rather well separated, those of the interstitial series nearly similar. Length 6.0 mm.; width 2.8 mm. Texas (El Paso).....**politum** Csy.

25 — Body more or less pale testaceous in color throughout.....26

Body dark castaneous to black.....27

26 — Form very stout, oblong-suboval, only moderately convex and shining; head with strongly converging, broadly arcuate sides before the eyes, the punctures rather coarse and deep but well separated, the middle of the occiput largely impunctate; prothorax nearly four-fifths wider than long, rather strongly, moderately sparsely punctured, gradually densely, more coarsely and confluently so broadly toward the sides, the latter broadly arcuate, somewhat abruptly converging and feebly sinuate anteriorly, the apex deeply sinuate, much narrower than the base; scutellum very well developed, strongly transverse, arcuato-truncate; elytra distinctly less than one-half longer than wide, very obtusely ogival at tip, with the usual punctured series, the punctures becoming very coarse and close-set in all series toward the sides, more or less confused near the humeral callus; abdomen sparsely and very unequally punctate, very coarsely toward the sides. Length 7.0–7.4 mm.; width 2.8–3.3 mm. California (Barstow).

testaceum n. sp.

Form moderately stout, polished, much smaller in size; head with the sides before the eyes less converging and strongly, evenly arcuate, becoming parallel near the eyes, the punctures close-set, moderately coarse; prothorax large, three-fourths wider than long, subparallel, the sides evenly and rather strongly arcuate, the apex but little narrower than the base, as wide at the middle as the widest part of the elytra, coarsely, deeply, perforately and rather closely punctured, the punctures very gradually still coarser and longitudinally confluent broadly toward the sides; scutellum small, slightly transverse, rounded behind; elytra scarcely one-half longer than wide, with series of strong, close-set punctures, those of the single interstitial series still coarser and very widely separated; abdomen sparsely but rather strongly punctured. Length 6.0 mm.; width 2.5 mm. Texas (locality unknown).

ludificans n. sp.

Form narrowly elongate-suboval, strongly convex, shining; head nearly as in *ludificans* throughout; prothorax relatively small, distinctly narrower than the elytra, three-fourths wider than long, subparallel, evenly and distinctly arcuate at the sides, the apex but slightly narrower than the base, the punctures strong, rather sparse, gradually coarse and elongate and then very coarse and confluent toward the sides; scutellum very small, but little wider than long; elytra more elongate, three-fifths longer than wide, with regular principal and subequal interstitial series of punctures, becoming very coarse and moderately close-set toward the sides, the interstitial punctures, as usual, rather more widely separated than those of the principal series; abdomen finely, sparsely punctured toward the middle. Length 5.6 mm.; width 2.28 mm. Arizona (southern).....**piceum** Csy.

27 — Form more parallel, the prothorax about as wide as any part of the elytra 28

Form somewhat inflated posteriorly, the prothorax evidently narrower than the widest part of the elytra; wings probably less developed.

29

28 — Form slender, convex, shining, black, the legs piceo-rufous; head coarsely, closely punctate, with a small irregular occipital impunctate spot, the sides before the eyes converging and evenly, strongly arcuate to the truncate apex; prothorax unusually convex, well developed, fully three-fourths wider than long, subparallel, evenly and rather strongly arcuate at the sides, the apex but little narrower than the base, the basal angles minutely prominent, the punctures somewhat coarse, deep, well separated, becoming only slightly coarser toward the sides, somewhat abruptly dense and confluent in not more than lateral fifth; scutellum well developed, transverse, broadly angulate at tip; elytra not quite three-fifths longer than wide, strongly punctured in not very close-set series, the punctures of the intervals similar but still more widely spaced; abdomen finely but deeply, not very sparsely punctate medially. Length 5.7–6.0 mm; width 2.4 mm. Arizona (southern).

emarginatum Csy.

Form still more elongate and slender than in *emarginatum*, black, more piceous beneath, the legs and antennæ rufous, the elytral suture rufescent, rather shining; head fully two-thirds as wide as the prothorax, coarsely, not very deeply, moderately closely punctate, the occipital spot large and well defined, the sides converging and evenly, moderately arcuate; prothorax scarcely two-thirds wider than long, parallel, the sides evenly and moderately arcuate, the basal angles nearly right, scarcely prominent, the punctures moderately coarse, rather sparse, becoming somewhat abruptly coarse, dense and confluent in less than lateral fifth; scutellum moderate, transverse; elytra fully three-fifths longer than wide, rapidly and ogivally rounded at tip, more obtusely than in *emarginatum*, barely three times as long as the prothorax as in that species, the punctures more close-set in the series, less coarse and strongly muricate laterally, the interstitial series regular except on the first and second intervals, which are confusedly punctate; abdomen finely and sparsely but distinctly punctured medially. Length 6.0 mm.; width 2.3 mm. Arizona (Riverside),— H. F. Wickham. ....**fatigans** n. sp.

Form somewhat similar but stouter, parallel, the size larger, deeper black, more highly polished, the legs and antennæ rufous, rather strongly convex; head nearly three-fifths as wide as the prothorax, coarsely, evenly and densely cribrate, the punctures nearly in contact but not crowded, the occipital spot irregular and ill-defined, the sides moderately converging and nearly straight from the eyes to the broadly rounded angles; prothorax almost four-fifths wider than long, parallel, the sides subevenly and rather strongly arcuate, the basal angles right, minutely and distinctly prominent, the punctures moderate and sparse medially, becoming gradually very coarse and closer and finally dense and coalescent

laterally; scutellum small, transverse; elytra but little more than one-half longer than wide, obtusely and ogivally rounded at tip, barely three times as long as the prothorax, the punctures rather strong, sparse, smaller and confused near the suture, coarse and rather close-set in series laterally, with the interstitial punctures still larger and more distant in the series, all the punctures much coarser and closer near the humeri; abdomen not very finely or sparsely and conspicuously punctured medially. Length 7.3 mm.; width 2.85 mm. Texas (El Paso).....**cribriceps** n. sp.

Form very stout, convex, shining, rufo-castaneous, the elytra sometimes picescent, the under surface and legs paler, rufous; head relatively rather small, scarcely more than half as wide as the prothorax, coarsely, deeply, closely and perforately punctate, the sides rather strongly converging and broadly, evenly arcuate; prothorax not quite twice as wide as long, distinctly narrowed toward apex, the sides strongly, subevenly arcuate, the punctures strong, sparse, gradually becoming larger and closer laterally, very coarse and dense though imperfectly confluent near the sides; scutellum transverse, minutely punctate; elytra short, barely one-half longer than wide, the serial punctures rather close-set, the interstitial larger and more widely spaced; abdomen strongly but finely, moderately sparsely punctate toward the middle. Length 6.0–6.3 mm.; width 2.7–2.8 mm. Texas (Laredo).

cognitum n. sp.

29 — Form moderately stout, convex, dark castaneous, the under surface and legs rufo-piceous, moderately shining; head with moderately small, deep and well separated punctures, the sides before the eyes converging and broadly, evenly arcuate for an unusually long distance to the truncate apex; prothorax large, only very slightly narrower than the elytra, fully three-fourths wider than long, evidently narrowed at apex, the sides moderately and subevenly arcuate, the punctures toward the middle not large but very deep and rather sparse, gradually becoming very coarse and close, elongate but not confluent toward the sides; scutellum small, but little wider than long; elytra one-half longer than wide, with broadly arcuate sides and obtusely ogival apex, strongly punctured in not very close-set series, the punctures of the interstitial series widely separated; abdomen minutely, sparsely punctate medially. Length 6.0–6.5 mm.; width 2.6–2.78 mm. California (Barstow) .....**concors** n. sp.

30 — Pronotum sparsely punctured, becoming more or less abruptly very much more coarsely so in about lateral fifth.....31

Pronotum more coarsely, deeply and more or less closely punctured, very gradually and less notably more coarsely so broadly toward the sides.....35

31 — Pronotal punctures in the broad median area strong and deep, much larger than in the four following species. Body small in size, stout, oblong-oval, convex, rather shining, black, the legs

rufous; head moderately coarsely, deeply and not very closely punctate, with a large occipital impunctate spot, the sides before the eyes obviously converging and evenly, strongly arcuate; prothorax nearly four-fifths wider than long, only very slightly narrower than the widest part of the elytra, the two bases equal, the apex much narrower than the base, strongly sinuate, widest rather behind the middle, with the sides subevenly and strongly arcuate, the lateral punctures coarse and anastomosing, forming long irregular rugæ; scutellum moderate, slightly transverse, angulate; elytra short, not more than two-fifths longer than wide, narrowly parabolic at tip, the series somewhat uneven and with not very coarse punctures laterally, the punctures of the interstitial series more widely spaced; abdomen sparsely punctulate medially. Length, 5.7–6.0 mm.; width 2.4–2.5 mm. California (San Diego).....**tersum** n. sp.

Pronotal punctures in a broad median area very minute and sparse..32

32 — Elytral series distinct to the suture, although composed of very fine punctures toward the latter and with the interstitial punctures there confused as usual. Southern California.....33

Elytral punctures very minute, sparse and wholly confused broadly toward the suture. Utah.....34

33 — Form narrowly subcylindric, parallel and strongly convex, rather shining, castaneous, the legs dark rufous, with the hind tarsi much shorter than the tibiæ; head broad, with rather coarse, deep, perforate and somewhat widely separated punctures, which become finer and sparse at the middle of the occiput, the sides strongly converging and broadly arcuate before the eyes; prothorax large, fully as wide as the elytra, barely three-fifths wider than long, widest somewhat behind the middle, with the sides evenly, rather feebly arcuate, the apex much narrower than the base, the punctures near the sides coarse, elongate and rather close-set but not longitudinally confluent; scutellum moderate; elytra fully three-fifths longer than wide but only two and one-half times as long as the prothorax, the serial punctures laterally becoming especially coarse and close-set toward the humeri. Length 6.7 mm; width 2.75 mm. Southern California.

cylindricum Csy.

Form nearly as in *cylindricum* but shorter, with a more transverse prothorax, convex, rather shining but with a feeble opalescent lustre, dark piceous, the legs paler; head well developed, with the sides moderately converging and strongly arcuate, becoming subparallel near the eyes, the punctures deep, only moderately coarse and rather close-set, becoming much coarser and sparser along the base and toward the eyes, the occipital smooth spot large but ill-defined; prothorax large, four-fifths wider than long, widest behind the middle, the sides distinctly arcuate, becoming gradually convergent and straighter anteriorly, the basal angles nearly right and evidently prominent, the punctures medially

sparse and small but less minute than in *cylindricum*, moderately coarse, dense, coalescent and forming long rugæ in lateral fifth; scutellum very well developed, strongly transverse; elytra evidently less than one-half longer than wide, as wide as the prothorax and about two and one-half times as long, very obtusely and ogivally rounded at tip, the sides feebly arcuate, the punctures suturally very fine and sparse, becoming coarse and close-set in the series laterally, where the punctures of the interstitial series are equal in size but much more widely spaced; abdomen minutely, sparsely punctured medially. Length 6.4–6.8 mm.; width 2.75–2.9 mm. Nevada (Las Vegas) .....**nevadense** n. sp.

Form stout, especially in the female, moderately convex, oblong-subovaI, shining, the elytra feebly alutaceous, castaneous, the under surface and legs rufous; head finely, sparsely punctate, more closely on the front, the occiput feebly, longitudinally rugulose, the sides before the eyes strongly converging and broadly arcuate; prothorax about as wide as the elytra, transverse, four-fifths wider than long or even more, widest and prominently rounded at the sides just behind the middle, thence strongly narrowed and sometimes with subsinuate sides to the deeply sinuate apex, the basal angles minutely subprominent; punctures toward the sides coarse and close but only imperfectly confluent; scutellum large and well developed, strongly transverse, impunctate except finely at base; elytra only two-fifths longer than wide but almost three times as long as the prothorax, the serial punctures only moderately coarse, subelongate and close-set toward the sides, those of the interstitial series more widely spaced; abdomen very sparsely punctulate medially. Length 6.4–7.5 mm.; width 2.6–3.25 mm. California (Kern Co.)..... ..... **gulosum** n. sp.

34 — Body stout, elongate-oval, rather convex, somewhat strongly shining, castaneous to dark testaceous, the legs dark rufous; head closely and rather coarsely punctured, the sides before the eyes only moderately converging and broadly arcuate; prothorax distinctly narrower than the median parts of the elytra, three-fourths wider than long, obviously narrowed at apex and deeply sinuate, widest just behind the middle, the sides evenly and moderately arcuate, the punctures more broadly dense toward the sides than in the three preceding species, moderately coarse and longitudinally confluent, forming long rugæ; scutellum large, very strongly transverse, finely punctate throughout; elytra two-fifths longer than wide, ogival at tip, the sides broadly, feebly arcuate, the series on the flanks rather irregular and composed of unusually small close-set punctures. Length 6.8–7.0 mm.; width 2.8–3.0 mm. Utah (southwestern).....**subovale** n. sp.

35 — Scutellum large, strongly transverse, in great part finely punctate. Form stout, oblong-oval, convex, moderately shining, black, the legs very dark rufous; head broad, with slightly separated and moderately coarse deep punctures, longitudinally

confluent near the orbital carinæ, the sides before the eyes strongly converging and strongly, evenly arcuate, becoming subparallel near the eyes; prothorax large, subequal in width to the elytra, fully four-fifths wider than long, distinctly narrowed toward the broadly sinuate apex, the sides evenly and moderately arcuate; punctures small but deep and rather close-set, gradually moderately coarse and forming long rugæ toward the sides; elytra two-fifths longer than wide, obtusely ogival at tip, just visibly inflated posteriorly, the series laterally composed of only moderately coarse, elongate and approximate punctures, those of the intervals almost similar; abdomen finely and sparsely but strongly punctate. Length 7.0 mm.; width 3.15 mm. California (Catalina Island)..... **insulare** n. sp.

Scutellum small or moderate..... 36

36 — Sides of the prothorax more or less abruptly, strongly converging and straight or feebly sinuate toward apex.....37

Sides of the prothorax evenly rounded.....38

37 — Body stout, oblong-oval, convex, shining, the elytra slightly alutaceous, black, the legs very dark rufo-piceous; head not very coarsely, irregularly and in great part rather sparsely punctate, the sides before the eyes strongly converging, broadly and evenly arcuate; prothorax four-fifths wider than long, the sides subparallel or very feebly diverging and nearly straight from the basal angles to slightly before the middle, there rather prominently rounded, the apex much narrower than the base and very deeply sinuate; punctures strong and close-set, becoming only slightly coarser but dense and longitudinally confluent toward the sides; scutellum transverse, broadly rounded, impunctate; elytra one-half longer than wide, slightly wider than the prothorax, very obtuse at apex, the sides very slightly arcuate, the series somewhat uneven, composed of very coarse punctures which are broadly confused basally toward the humeral callus; abdomen finely rugulose, finely, sparsely punctate. Length 7.2 mm.; width 3.22 mm. California (San Bernardino Co.).

gravidum n. sp.

Body stout, shorter, oblong-oval, moderately convex and shining, castaneous, the legs rufous; head rather coarsely, perforately, somewhat unevenly and moderately closely punctate, the sides before the eyes distinctly converging, evenly and strongly arcuate; prothorax widest behind the middle, where the sides are broadly, strongly arcuate, thence converging and less arcuate to the base, the apex much narrower than the base and deeply sinuate, the punctures strong and close-set, becoming but little coarser but longitudinally confluent toward the sides; scutellum small, wider than long, angulate; elytra two-fifths longer than wide, very obtusely parabolic at tip, only very slightly wider than the prothorax, the sides evidently arcuate, the series in great part very uneven, composed of close-set, moderately coarse punctures,

those of the intervals widely spaced; abdomen finely, sparsely punctate medially. Length 6.5 mm.; width 2.95 mm. Probably southern California..... .....**edax** n. sp.

Body decidedly less stout, convex, elongate-oval, rather shining, dark blackish-castaneous, the legs rather bright rufous; head rather finely, irregularly and moderately closely punctured, the sides moderately converging and evenly arcuate before the eyes, prothorax much less transverse, scarcely more than two-thirds wider than long, widest behind the middle, the sides almost evenly arcuate, becoming feebly sinuate near the apex, which is much narrower than the base and rather deeply sinuate, the punctures moderately large, deep and well separated, becoming much coarser, dense and longitudinally confluent toward the sides; scutellum moderately large, minutely punctate, subangulate; elytra nearly one-half longer than wide, obtusely ogival at tip, evidently wider than the prothorax, with arcuate sides, the series somewhat uneven, with more widely spaced punctures than in *edax* and becoming less confused at base; abdomen finely, very sparsely punctate medially. Length 6.4 mm.; width 2.8 mm. California (Colorado Desert), — G. W. Dunn.....**molestum** n. sp.

Body shorter and stouter than in any of the three preceding species; black, the legs dark rufo-piceous, moderately shining, the entire elytra opaque; head well developed, not very coarsely or closely punctate, the occipital spot ill-defined, the sides feebly converging but strongly arcuate, becoming subparallel for some distance before the eyes; prothorax almost three-fourths wider than long, the sides distinctly arcuate, more converging and straight anteriorly, the basal angles obtuse, not blunt or prominent, the punctures rather coarse, perforate, moderately separated medially, becoming gradually coarse and dense toward the sides; scutellum moderate, tumid, punctate; elytra short, a third longer than wide, rapidly narrowed and very obtusely ogival in apical two-fifths, the sides feebly arcuate, the disk distinctly wider than the prothorax and barely two and one-half times as long, the punctures only moderately coarse, very strongly muricate and close-set in even series laterally, with the interstitial punctures less conspicuous and more widely spaced, the punctures small, sparse, muricate and largely confused suturally; abdomen polished, finely, moderately sparsely but distinctly punctate medially. Length 6.6 mm.; width 2.9 mm. California (southern). **opacipenne** n. sp.

38 — Form rather stout, oblong, subparallel, rather convex, black, the legs somewhat bright rufous; head somewhat coarsely, perforately and rather closely punctate, the sides before the eyes strongly converging, evenly and very moderately arcuate; prothorax about as wide as the elytra, the sides evenly, rather strongly arcuate, slightly more converging anteriorly than posteriorly, the apex moderately sinuate; punctures strong, somewhat uneven and rather close-set, becoming gradually much coarser and longitudi-

nally confluent toward the sides; scutellum moderately large, transversely oval: elytra distinctly less than one-half longer than wide, equal in width to the prothorax and between two and three times as long, obtusely ogival at tip, the sides very slightly arcuate, the series more or less uneven, composed of moderately coarse, not very close-set punctures, which are largely confused toward base: abdomen minutely, sparsely punctate medially. Length 6.2–7.0 mm.; width 2.65–2.83 mm. California (Colorado Desert).....**convexicolle** Lec.

Form somewhat as in *convexicolle* but a little more elongate, stout, suboval, convex, polished, black with a piceous tinge, the legs and antennæ piceo-rufous; head well developed, not very coarsely and only moderately closely punctate, the punctures finer but also separated anteriorly, coarse and confluent toward the eyes, the sides converging and broadly arcuate; prothorax three-fourths wider than long, widest well behind the middle, the sides arcuate, gradually and rather strongly converging and less arcuate anteriorly, the basal angles right and minutely prominent, the punctures moderately coarse, deep and close-set, becoming gradually much coarser and very dense laterally; elytra nearly one-half longer than wide, very obtusely ogival at apex, very evidently wider than the prothorax and three times as long, the sides feebly arcuate, the punctures small but deep, confused and moderately sparse suturally, moderately coarse, strongly muricate and close-set in equal close-set series laterally, a little coarser near the humeri; abdomen minutely, sparsely punctate medially. Length 6.8 mm.; width 3.0 mm. California (southern).....**integer** n. sp.

Form stout, moderately convex, shining, dark castaneous, the under surface and legs dark rufous; head rather coarsely, deeply and moderately closely punctate, the sides before the eyes strongly converging and evenly, moderately arcuate; prothorax transverse, almost twice as wide as long, very slightly narrower than the elytra, slightly narrowed toward the broadly sinuate apex, the sides rather strongly, subevenly arcuate, the punctures very coarse and deep, close-set, becoming gradually but little coarser but longitudinally confluent toward the sides, the surface obliquely subrugulose anteriorly and posteriorly almost throughout the width; scutellum small, but little wider than long, angulate and punctured; elytra one-half longer than wide, ogival at tip, with the sides broadly arcuate, the series rather uneven but distinctly traceable throughout, except near the suture, the punctures moderately coarse and close-set, not confused toward the humeri; abdomen minutely, sparsely punctate medially. Length 5.7–6.6 mm.; width 2.4–2.85 mm. Southern California..... **probatum** n. sp.

39 — Form stout, oblong-oval, rather strongly convex, alutaceous, piceous-black, the head, prothorax, sterna and legs dark rufus, the abdomen black except at apex; head coarsely, closely and unevenly punctate, with a large impunctate occipital area, the sides before the eyes very strongly converging and broadly arcuate to

the apex, which is narrower than usual and feebly sinuate; prothorax four-fifths wider than long, the sides parallel and feebly arcuate to beyond the middle, then rounded, becoming rectilinearly converging to the apex, which is much narrower than the base and deeply sinuate; punctures fine and moderately close-set, becoming rather rapidly coarse, close and subconfluent toward the sides; scutellum well developed, transverse, broadly angulate; elytra inflated posteriorly, barely two-fifths longer than wide, very obtuse at apex, much wider than the prothorax, with arcuate sides, the punctures non-setigerous, fine, feeble, rather sparse and confused toward the suture, larger, but still not very coarse and disposed in the usual series toward the sides; abdomen finely, sparsely punctulate medially. Length 6.2 mm.; width 2.9 mm. Arizona ..... **bicolor** Horn

In nearly all the species above described the elytral punctures bear each a short, stiff, erect seta, becoming more conspicuous toward the sides and more evident in some forms than in others. There is visible also in most of the species, on the elytral flanks near the side margin and about two-fifths the length from the base, a short longitudinal impression and the surface at the humeral angles is more or less prominent, sometimes forming a distinct callus, which is generally paler in color than the remainder of the elytra. The male can frequently be recognized by the acute and slightly upturned sheath, finely cleft and inclosing the very slender intromittent spicule, and the female by the truncate end of the spatuliform and basally narrowed oviduct, protected by longitudinal lateral pieces, but there is very little sexual difference in the form of the body and no obvious secondary sexual characters. It should be noted that the elongate forms, having well developed wings, are virtually confined to Arizona, being very rare elsewhere, while those with short metasternum and abbreviated wings are by far the most abundant type in southern California.

It will be observed that the characters given for some of the above species are more or less at variance with those stated in my revision, before cited. For example, on page 331, the form of *dubium* is said to be slender, while in reality the true *dubium* has an unusually broad form of body. These inconsistencies, in great part, arise from the fact that in my previous treatment of the group I endeavored to fall in line with the then prevailing tendency to lump various forms together, without due investiga-

tion, and the types of *dubium*, and the very much narrower *carbonatum*, were combined to form a composite *dubium*, of which the assumed male was slender. Further study shows that all the species hitherto described, except perhaps *sculptile*, are abundantly valid, and I have so regarded them in the above table. The species, as in *Zopherodes*, *Asida* and many other Tenebrionid genera, although very numerous, are more or less local and usually rare individually, so that a considerable proportion of those in my cabinet are represented at present by single specimens. If one should proceed upon the assumption that the very obvious differential characters presented by these types are not permanent, no satisfactory classification for the species could be devised, for no limit could be set to fortuitous variation in the various composite groups of individuals, arbitrarily brought together under a few distinctive names, which is the condition prevailing in nearly all collections at the present time. These remarks apply also to all the other genera of this, as well as to the succeeding tribes here considered.

Telabis Csy.

It seems more consistent to regard this group of species as a genus, and not as a subgenus as originally proposed. The species differ considerably from those of *Metoponium* in general facies, and can usually be recognized at a glance, without referring to the biemarginate frontal margin or the structure of the hind tarsi, where the first joint is very much longer than the last. The genus is divisible into two groups, one composed of larger species, which are less numerous and more or less widely isolated among themselves, and the other comprising a host of small species, which are mutually more closely allied in some parts of the series and more difficult to define satisfactorily. In my previous paper the very distinct *punctulata*, of LeConte, is said to have a peculiar male sexual character relating to the fourth segment. Dr. Horn states that this character pertains to the female. The single specimen before me possessing this singular modification of the fourth abdominal segment, sheds but unsatisfactory light on this point, as the œdeagus is only slightly protruded, but such characteristics as are visible appear

to support the statement of Horn. The species in my cabinet may be briefly outlined as follows: —

Larger species, not materially under 6.5 mm. in length, the metasternum always very much longer than the first ventral segment..2

Small species, always under 6.0 mm. in length, the metasternum shorter, though at least slightly longer than the first ventral.....9

2 — Metasternum nearly twice as long as the first ventral; elytra very long, generally between four and five times as long as the prothorax, with broadly and feebly impressed longitudinal lines almost throughout the width.....3

Metasternum much less than twice as long as the first ventral, the elytra never more than four times as long as the prothorax and usually much less, and without such broadly impressed longitudinal lines..... 4

3 — Form oblong-elongate, parallel, rather shining, piceous-black, the head, pro- and mesosterna and legs piceo-rufous, broadly and moderately convex; head very short and broad, densely, moderately coarsely and shallowly muricato-punctate, the sides before the eyes feebly converging and very strongly arcuate, becoming parallel at the eyes; prothorax small, rather more than twice as wide as long, the sides narrowly but strongly reflexed, evenly and strongly arcuate, the apex deeply sinuate but only slightly narrowed, the punctures moderate, shallow, muricate and close-set, becoming densely crowded but only slightly larger toward the sides; elytra three-fourths longer than wide, almost five times as long as the prothorax and nearly a third wider, parallel, obtusely parabolic at tip, the humeri broadly exposed at base, the punctures moderate, shallow and irregularly seriate laterally, minute and confused broadly toward the suture, the intervals laterally generally with minute confused punctures; abdomen minutely but rather closely punctate. Length 9.2 mm.; width 3.78 mm. New Mexico (Albuquerque)..... .....**longipennis** Csy.

Form similar, the size smaller, rather shining, pale rufo-castaneous, the legs brighter rufous; head nearly as in *longipennis*, the eyes similarly large and rather prominent; prothorax less transverse, much more narrowed toward the deeply sinuate apex and with the sides evenly and still more strongly arcuate, fully twice as wide as long, the punctures more minute and rather sparser toward the middle, coarser and close but not so crowded toward the sides; elytra three-fourths longer than wide, more than four times as long as the prothorax but only a fifth or sixth wider, parallel, obtusely subogival at apex, the humeri well exposed in the reëntrant angle, finely, not densely, irregularly punctate throughout, the summits of the feeble ridges between the impressed lines subimpunctate, the punctured series more or less irregular even laterally, sometimes almost indistinguishable; abdomen minutely, sparsely punctulate. Length 6.5–7.7 mm.; width 2.65–3.15 mm. Texas (near El Paso).....**discors** Csy.

4 — Surface of the pronotum obliquely and feebly prominent toward the basal angles..... 5

Surface of the pronotum evenly convex near the posterior angles.....8

5 — Pronotum not very obviously impressed near the sides at base; body stouter in form 6

Pronotum with a large rounded impression, at base laterally, between the oblique prominence and the basal margin 7

6 — Body stout, oblong, feebly alutaceous, castaneous, the under surface and legs paler, rufous; head rather finely, muricately, somewhat unevenly but not densely punctate, broad, the sides but feebly converging before the eyes and strongly arcuate, becoming parallel at the eyes, which are large; prothorax three-fourths wider than long, widest distinctly behind the middle, where the sides are rather strongly rounded, thence converging and evenly, very feebly arcuate to the apical angles, which are not in the least everted; punctures fine and sparse, with a narrow impunctate median line, stronger, muricate and closer but still well separated laterally; elytra two-thirds longer than wide, not quite four times as long as the prothorax and a fourth wider, obtusely rounded in apical third, the sides very feebly arcuate, the punctures small, muricate, slightly larger laterally, close-set in rather even, broadly and feebly impressed series, the intervals minutely, sparsely, irregularly punctate. Length 7.0 mm.; width 3.1 mm. Texas (near El Paso) .....**muricatula** Csy.

Body nearly similar in coloration and lustre, the under surface more blackish; head rather smaller, with somewhat sparser and still more irregular punctures but otherwise similar, except that the transverse epistomal surface is more tumid; prothorax very much shorter and more transverse, widest near the middle, narrowed at apex, twice as wide as long, the sides subevenly and strongly arcuate throughout, except for a very short distance at the apical angles, which are prominently everted, the punctures still more minute and sparser, with a much less elongate impunctate line, coarser, closer and muricate but distinctly separated toward the sides; elytra shorter, three-fifths longer than wide, less than four times as long as the prothorax and not over a fifth wider, obtusely parabolic in apical third, the punctures finer, arranged in similar series, which are however less impressed, the interstitial punctures extremely minute, sparse and irregular. Length 6.5 mm.; width 2.8 mm. Texas (near El Paso).....**prominens** n. sp.

Body stout and strongly convex, oblong, strongly shining, pale rufotestaceous throughout; head rather finely but deeply, sparsely and non-muricately punctate, very densely so anteriorly, the sides moderately converging and strongly arcuate, the apex feebly sinuatotruncate; prothorax scarcely more than two-thirds wider than long, widest slightly behind the middle, the sides rather strongly arcuate, becoming straight toward the apical angles, which are right and not rounded, the apex rather feebly sinuate and four-

fifths as wide as the base, the angles obtuse but not rounded, the punctures very fine and sparse, becoming gradually rather coarse, muricate, close but still separated toward the sides; scutellum moderate, transverse; elytra nearly one-half longer than wide, three times as long as the prothorax and nearly a fifth wider, the sides feebly arcuate, the humeri but slightly exposed at base, the apex obtusely rounded, the punctures fine, becoming rather coarse laterally, close-set in wholly unimpressed series, the intervals minutely, sparsely and more or less confusedly punctate; surface on the posterior declivity having two or three feebly elevated lines, which bear small and widely separated asperities; abdomen very finely, sparsely punctate medially. Length 6.5 mm.; width 2.85 mm. Texas (El Paso), — H. F. Wickham.....**rubida** n. sp.

7 — Form oblong-elongate, moderately convex, blackish-castaneous, the under surface and legs in great part rufous; surface feebly alutaceous; head closely, shallowly and muricately punctate, minutely and sparsely so on the occiput, the sides before the eyes strongly convergent, evenly and moderately arcuate, the epistoma tumid and densely sculptured; prothorax nearly four-fifths wider than long, widest near the middle, the sides rather strongly, subevenly rounded, more converging anteriorly, becoming broadly and just visibly sinuate behind the apical angles, which are acute, the apex deeply sinuate, the lateral edges very narrowly reflexed and minutely, obsoletely serrulate, the punctures minute and sparse, becoming larger and muricate but still well separated toward the sides; elytra as in *prominens*, three-fifths longer than wide and a fourth wider than the prothorax, closely and rather strongly punctured in nearly even, unimpressed series, the intervals unevenly uniseriate, the punctures rather close-set but in great part confused toward base; abdomen polished as usual, minutely, sparsely punctulate. Length 6.7 mm.; width 2.7 mm. Arizona (near Benson)..... .....**vafra** n. sp.

Form similar to the preceding, rather more shining, castaneous, the under surface and legs bright rufous; head nearly as in *vafra* but decidedly smaller and more obviously impressed at the middle of the vertex; prothorax rather more transverse though similar in form and rotundity of the sides, the latter more converging and straight anteriorly, with the angles right and not all prominent, the punctures fine and sparse, becoming decidedly larger, only slightly muricate and well separated toward the sides; elytra as in *vafra* but much more finely and feebly punctate in subeven series, with the interstitial punctures minute, feeble, sparse and irregular, not over a fifth wider than the prothorax; abdomen similarly very minutely, feebly and sparsely punctulate and strongly convex. Length 6.5 mm.; width 2.65 mm. Texas (near El Paso) .....**proxima** n. sp.

8 — Form oblong-suboval, moderately convex, strongly alutaceous and but feebly shining, pale ferruginous throughout; head rather

finely, densely but not deeply, muricately punctate, the sides before the eyes strongly converging, evenly and moderately arcuate, the eyes large; prothorax barely twice as wide as long, widest at the middle, where the sides are strongly rounded, thence moderately converging and nearly straight to the obtuse basal angles and more convergent, becoming broadly and just visibly sinuate, to the apical angles, which are right and not prominent, the apex deeply sinuate; punctures rather fine, shallow, close-set, with a narrow impunctate median line from which they become gradually slightly larger, muricate and dense toward the sides; elytra as in the preceding species, fully a fifth wider than the prothorax, with broadly arcuate sides, the punctures fine, strongly muricate, close-set and uneven, with irregular and close-set unimpressed series, in which the punctures are only slightly larger; abdomen finely, sparsely punctured, convex, the fourth segment in the apparent female with a porrect median lobe. Length 6.6 mm.; width 2.8 mm. Lower California (Cape San Lucas).
punctulata Lec.

Form oblong-oval, convex, black throughout, the legs rufous; head and pronotum densely opaque, the elytra feebly shining, alutaceous; head not very coarsely but closely, moderately strongly punctate, the epistoma moderately convex, densely sculptured, the sides before the eyes feebly converging and broadly arcuate, becoming parallel at the eyes, which are only moderately developed; prothorax well developed, fully four-fifths wider than long, widest at about the middle, moderately narrowed toward the normally sinuate tip, the sides strongly and almost evenly arcuate, the punctures fine, shallow, moderately close, becoming gradually dense, muricate and moderately coarse toward the sides; elytra one-half longer than wide, scarcely more than three times as long as the prothorax and but very little wider, obtusely rounded at tip, the sides feebly arcuate, finely but rather strongly, muricately and confusedly punctate, with slightly uneven, feebly impressed series of but slightly larger, close-set punctures, the second series from the sides more strongly impressed behind the humeri. Length 7.4 mm.; width 3.15 mm. California (San Diego).
opacella n. sp.

Form oblong, subparallel, moderately convex, rather strongly shining throughout, castaneous, the under surface and legs rufous; head finely but deeply, muricately and rather closely punctate, the sides before the eyes moderately converging and strongly arcuate, the eyes rather prominent; prothorax widest at about the middle, fully three-fourths wider than long, moderately narrowed and sinuate at apex, the sides evenly and strongly arcuate, the punctures fine and rather sparse with the surface shining, rather rapidly larger, somewhat coarse, muricate and crowded laterally; elytra three-fifths longer than wide, not four times as long as the prothorax and about a fifth wider, obtusely or subcircularly rounded at tip, parallel, with the sides almost straight

thence to the humeral arcuation, the punctures fine, sparse and irregular, with well marked, feebly impressed series of larger close-set punctures, becoming rather coarse but irregularly crowded toward the sides. Length 7.3–7.7 mm.; width 3.2 mm. Arizona. **histrica** Csy.

Form oblong, nearly as in *histrica* but less elongate, similarly rather shining, black, the legs dark rufous; head dull and nearly similar but less transverse and more finely, rather sparsely punctate, the sides equally converging but more strongly arcuate, the angles more broadly rounded and much less evident, the epistoma feebly sinuato-truncate; prothorax more transverse, nearly four-fifths wider than long, almost similar in form and punctuation, the minute medial punctures rather less sparse; scutellum somewhat less developed but similarly narrowed toward base and punctulate in basal half; elytra one-half longer than wide, but little more than three times as long as the prothorax and about a sixth wider, the sides parallel and nearly straight, the humeri rounded and the apex abruptly and very broadly rounded in posterior fourth, the sculpture nearly as in *histrica* but with the striæ feebly impressed and the slightly elevated double series of small, widely spaced subsutural asperities on the posterior declivity rather more pronounced; abdomen very finely rugulose, minutely and sparsely punctate medially. Length 6.5 mm.; width 2.9 mm. Arizona (Tucson), — H. F. Wickham.....**obtusa** n. sp.

9 — Pronotal punctures usually fine, aciculate or muricate and very dense, the surface generally dull in lustre; body oblong as a rule and moderately convex..... 10

Pronotal punctures larger and more or less widely separated, with the surface polished; body generally more oval and convex.....20

10 — Elytra alutaceous in lustre..... 11

Elytra highly polished and rather more convex 19

11 — Elytral punctures fine, sparse, feeble and slightly muricate, the punctured series indistinct and only traceable near the base. Body oblong, piceous-black, the under surface more rufous and the legs still paler, alutaceous throughout above; head strongly, densely and roughly punctured, the sides strongly converging and nearly straight, rapidly rounding at the apical angles, the epistoma broad, scarcely produced; prothorax four-fifths (♀) to nearly twice (♂) as wide as long, widest at the middle, the sides subevenly and moderately arcuate, the apex sinuate and slightly narrowed, the punctures very fine, moderately close-set, becoming larger, rough and very dense toward the sides; elytra two-fifths to one-half longer than wide, just visibly (♂) to a fifth or fourth (♀) wider than the prothorax, parallel and nearly straight at the sides, narrowing slightly at the base, the apex obtusely rounded; abdomen shining, minutely, sparsely punctate medially, less finely toward the sides. Length 5.0–5.3 mm.; width 2.2–2.38 mm. Utah (St. George), — H. F. Wickham.....**uteana** n. sp.

Elytral punctures nearly as in *uteana*, the head and scutellum much larger and the sides of the prothorax more rounded, pale testaceous in color, moderately shining, strongly convex; head two-thirds as wide as the prothorax, finely, moderately closely punctate, the sides strongly converging and feebly arcuate, the angles distinct but blunt, the emarginations distinct, the epistoma but feebly produced, broadly truncate; prothorax a little more than twice as wide as long, somewhat narrower at apex than at base, the sides evenly and strongly arcuate, the basal angles obtuse, not prominent, the punctures very fine and well separated medially, close-set, muricate and larger but not coarse laterally; scutellum large, rather more than a fourth as wide as an elytral base; elytra three-fifths longer than wide, gradually, arcuately rounded and obtuse posteriorly, three and one-half times as long as the prothorax and, at the middle, distinctly wider, the sides evenly, rather strongly arcuate, the humeri not exposed at base, the punctures muricate, fine, moderately close, larger laterally, in great part confused but with uneven and unimpressed series visible on careful examination; abdomen finely, sparsely punctate. Length 4.8 mm.; width 2.12 mm. Utah (Milford), — H. F. Wickham.
amica n. sp.

Elytra rather finely but more closely and distinctly punctate, the punctured series usually obvious almost throughout the length.....12

12 — Epistomal lobe distinctly produced, narrowed and sinuato-truncate at apex, the sides strongly oblique, the oblique frontal sutures very deep and distinct. Form elongate-suboval, rather shining and but feebly alutaceous, pale castaneo-furruginous, the legs rufous; head closely and shallowly muricato-punctate; eyes rather large and prominent, the sides before them strongly converging and nearly straight; prothorax four-fifths wider than long, widest at the middle, but little narrowed and rather feebly sinuate at apex, the sides parallel, evenly and moderately arcuate, the punctures fine and well separated medially, becoming rather coarse, very dense and scabrous laterally; elytra one-half longer than wide, three times as long as the prothorax and but very little wider, the sides feebly arcuate, the apex obtusely, evenly rounded, the punctures distinct and not very close-set, only slightly muricate, the series not impressed, the intervals with very uneven single series of subsimilar punctures; abdomen rather strongly and closely punctate. Length 4.8 mm.; width 2.1–2.22 mm. Arizona (Tucson), — H. F. Wickham.
lobifrons n. sp.

Epistoma not sensibly produced, broadly truncate, the oblique frontal sutures shallow and less distinct.....13

13 — Elytral series finely and feebly but obviously impressed, strongly, closely punctate, even and very distinct to the apex, the intervals strongly though less coarsely punctate in more or less uneven single series. Body elongate-oval, only moderately convex, but

slightly alutaceous, dark castaneous, the head, prothorax, under surface and legs more or less pale rufous; head strongly, evenly and rather closely punctate, the sides converging and but feebly arcuate; prothorax nearly four-fifths wider than long, distinctly narrower at apex and deeply sinuate, the sides evenly and strongly arcuate, the punctures fine but deep and moderately close-set medially, becoming moderately coarse, dense and scabrous laterally; elytra two-fifths longer than wide, a fourth or fifth (♀) wider than the prothorax, obtusely rounded at tip, the sides decidedly arcuate; abdomen finely and sparsely punctate medially, the last segment more closely as usual, the sides somewhat coarsely though just as sparsely. Length 5.6 mm.; width 2.5 mm. Texas (El Paso).....**mimetica** n. sp.

Elytral series not or scarcely impressed, less even or relatively less strongly punctured as a rule..... 14

14 — Species of southern California and western Arizona.....15

Species of eastern Arizona to western Texas.....16

15 — Form oblong, brown in color, the legs rufous; surface rather dull in lustre; head paler at the sides and apex, strongly and densely, subscabrously punctate, the sides strongly converging and feebly arcuate, the eyes moderate, rather prominent; prothorax not quite twice as wide as long, slightly narrowed and broadly sinuate at apex, widest at the middle, the sides evenly and strongly arcuate, the punctures small but muricate and close-set medially, becoming coarser, dense and scabrous laterally, the interstices opaque; elytra one-half longer than wide, a fifth wider than the prothorax, obtusely rounded at apex, the sides broadly, feebly arcuate, the punctures rather large but shallow and muricate, somewhat close-set and uneven, sometimes forming single series on the intervals toward base, the principal series rather uneven, composed of punctures but little larger than the interstitial but very close-set, the surface with broad, very obsolete longitudinal impressed lines. Length 5.7 mm.; width 2.42 mm. California (Inyo Co.).....**sodalis** Horn

Form oblong, piceous-black, the legs paler, piceo-rufous, the surface strongly alutaceous; head densely, moderately coarsely punctato-scabrous, the sides strongly converging and nearly straight, the eyes moderate; prothorax not quite twice as wide as long, evidently narrowed and deeply sinuate at apex, widest at the middle, with the sides evenly and strongly arcuate, the punctures very small, subelongated and close-set medially, becoming not very coarse, but dense, scabrous and somewhat obliquely substrigose laterally; elytra fully one-half longer than wide, rather more than three times as long as the prothorax and nearly a fourth wider, very obtusely parabolic at tip, the sides parallel, nearly straight, feebly rounding basally, the humeri feebly exposed at base; punctures rather small, shallow, submuricate, rather close-set and uneven, with irregular series of similar though somewhat

larger and more close-set punctures, which are very obsoletely and broadly impressed toward the suture: abdomen finely, sparsely punctate medially. Length 5.6 mm.; width 2.32 mm. California (San Diego).....**fidelis** n. sp.

Form nearly similar, piceous-black, the legs pale rufous, the surface rather strongly alutaceous; head not very coarsely, densely punctato-scabrous throughout, the sides strongly converging and nearly straight; prothorax small, nearly as in *fidelis*, but rather less transverse, about four-fifths wider than long, the sides evenly and rather more strongly arcuate, the punctuation throughout nearly similar but slightly stronger; elytra similar but rather more than a fourth wider than the prothorax, with the humeri more widely exposed at base, the punctures more confused, somewhat fine, shallow, slightly muricate and not very close-set, the series very irregular and observable with difficulty except toward base; abdomen minutely, sparsely punctate. Length 5.5 mm.; width 2.35 mm. Arizona (Peach Springs)..... .....**debilis** Csy.

16 — Abdomen finely, sparsely punctured medially, not rugulose....17

Abdomen rather coarsely, not so sparsely punctured even medially, its surface shining, but with small inequalities or rugulation...18

17 — Body oblong-subparallel, moderately stout, strongly alutaceous, piceo-castaneous, the under surface and legs paler and rufous; head rather coarsely, densely, muricately punctate, the sides converging and nearly straight; prothorax slightly though evidently less than twice as wide as long, distinctly narrowed and evenly sinuate at tip, the sides evenly and strongly arcuate, finely and closely punctate, the punctures becoming only moderately coarse but dense and scabrous laterally; elytra but little more than one-half longer than wide, scarcely three times as long as the prothorax and but little wider, very obtusely rounded at apex, the sides feebly arcuate, the series unimpressed, rather strongly, very approximately punctate, the intervals less strongly punctured in very uneven single series laterally; abdomen convex, finely, sparsely punctate. Length 4.6–4.8 mm.; width 2.1–2.2 mm. Texas (El Paso), — G. W. Dunn.....**crassula** Csy.

Body nearly as stout as in *crassula*, the head nearly similar, the prothorax shorter, twice as wide as long, evenly but less strongly rounded at the sides, the punctures similarly fine and close-set medially but rather stronger; elytra not quite one-half longer than wide, fully three times as long as the prothorax and slightly broader, the serial punctures similarly strong and close-set, those of the intervals more irregular and deeper; abdomen less sparsely punctured than in *crassula*; color black, with the legs rufo-piceous. Length 5.0 mm.; width 2.28 mm. Arizona (locality unknown, but probably southeastern).....**timida** n. sp.

18 — Form oblong-oval, convex, alutaceous, pale piceo-castaneous, the under surface and legs piceo-rufous; head opaque, not very

densely, somewhat coarsely, muricately punctate, the sides converging and straight before the eyes; prothorax only moderately transverse, but little more than three-fourths wider than long, distinctly narrowed but rather feebly sinuate at tip, the sides evenly and rather strongly arcuate, the disk widest somewhat behind the middle, opaque, minutely and closely but somewhat irregularly punctate, somewhat coarsely, densely and muricately toward the side; elytra fully one-half longer than wide, barely three times as long as the prothorax and only slightly wider, more shining, obtusely rounded at apex, parallel, with the sides feebly and evenly arcuate, the serial punctures rather strong and close-set, those of the intervals uneven in arrangement and smaller. Length 5.3 mm.; width 2.28 mm. Arizona.....**compar** n. sp.

Form oblong, dilated behind, short and stout, piceous-black, the legs and sterna rufous; head opaque, closely punctato-scabrous, the sides converging and nearly straight but with the angles broadly rounded at apex; prothorax very short, fully twice as wide as long, sinuate but only slightly narrowed at apex, the sides rounded but becoming straight or subsinuate apically, widest at the middle, the surface only alutaceous, more shining than in *compar*, the punctures comparatively coarse and separated by fully twice their own diameters, becoming but little coarser though dense and scabrous laterally; elytra short, two-fifths longer than wide but rather more than three times as long as the prothorax, obtusely ogival at apex, at apical third much wider than toward base, where they are but little wider than the prothorax, the serial punctures coarse and close-set, becoming gradually much smaller posteriorly, the interstitial punctures only a little smaller but sparser and uneven; abdominal sculpture strikingly coarse. Length 4.5 mm.; width 2.1 mm. Arizona (Tuçson).

curticollis n. sp.

Form narrow, convex, parallel, much smaller in size, piceous-black, the under surface rufo-piceous, the legs rufous; head trapezoidal, finely, closely and muricately punctate, the epistoma projecting only very slightly beyond the lateral lobes and very broadly, rectilinearly truncate, the converging sides before the eyes almost straight; prothorax alutaceous, twice as wide as long, nearly parallel, the moderately sinuate apex but little narrower than the base, the sides evenly, rather strongly arcuate, the basal angles very obtuse; punctures fine and well separated medially, becoming larger, dense and confusedly rugulose laterally; scutellum well developed, punctured basally; elytra one-half longer than wide, somewhat more than three times as long as the prothorax and sensibly wider in the male, rapidly and obtusely parabolic at tip, the sides parallel and feebly arcuate, the humeri only just visibly exposed at base; surface rather smooth and alutaceous, the series of close-set punctures distinct and not very coarse or strongly muricate, almost entire, unimpressed, the punctures of the intervals but little smaller, though feebler and more widely

spaced, generally in less even single series, confused near the suture; abdomen coarsely, rather closely punctured along the middle, but more sparsely so thence to the sides. Length 4.1 mm.; width 1.85 mm. Texas (El Paso), — H. F. Wickham.
vapida n. sp.

19 — Oblong-oval, stout, pale brownish-testaceous, the legs more flavo-rufous; head rather coarsely, densely punctato-scabrous, the sides strongly converging and nearly straight, the lateral lobes narrowly rounded at tip, the epistoma very broadly and moderately though distinctly produced and truncate, with its sides very oblique, the oblique sutures fine but distinct; prothorax transverse, not quite twice as wide as long, but little narrowed but deeply sinuate at apex, widest at the middle, the sides evenly and strongly arcuate, the surface slightly alutaceous, minutely, rather closely and muricately punctate, becoming rather coarsely, very densely punctato-scabrous laterally; elytra not quite one-half longer than wide, three times as long as the prothorax and a fifth wider, obtusely rounded at apex, the sides broadly and distinctly arcuate, the series of close-set and rather small but deep punctures unimpressed and slightly irregular, the intervals with confused and sparser but scarcely smaller punctures; abdomen minutely, sparsely punctate. Length 5.3 mm.; width 2.7 mm. California (probably near Yuma). [= *sodalis* Csy. nec Horn, olim].
incisa n. sp.

Oblong-oval, the elytra rather dilated posteriorly, piceous-black, the legs rufous; head coarsely, densely punctato-scabrous and dull, the frontal margin evidently biemarginate, the epistoma produced slightly and rectilinearly truncate, the sides before the eyes evenly converging and moderately arcuate; prothorax small, very nearly twice as wide as long, strongly narrowed and moderately sinuate at apex, widest and subinflated near basal third, the sides subevenly, rather strongly arcuate, especially toward base; punctures coarse, scabrous, slightly smaller and separated medially, very dense and rough laterally, the surface with a deeply impressed line along the basal margin throughout the width; scutellum well developed, somewhat punctate; elytra one-half longer than wide, between three and four times as long as the prothorax, and, posteriorly, distinctly wider, the sides broadly arcuate, the apex rapidly and obtusely ogival; punctures very coarse, strongly asperate, deep and close-set in rather confused and uneven unimpressed series, the single series of the intervals similarly coarsely and asperately but less closely punctate, causing the coarse sculpture to be very conspicuous, although the interspaces are polished, all series continuing unmodified to the apex; abdomen more finely, not very sparsely and subasperately punctate medially. Length 4.6–5.2 mm.; width 2.1–2.38 mm. Colorado (Salida), — H. F. Wickham .....**aspera** n. sp.

20 — Apical angles of the head narrowly rounded, the sides converging and straighter before the eyes; color generally dark.....21

Apical angles broadly rounded, the sides converging; epistoma somewhat projecting and truncate; color pale testaceous.....24

21 — Sides before the eyes feebly arcuate.....22

Sides before the eyes straight; body rufo-castaneous, the under surface paler and the legs rufous.....23

22 — Form narrow, oblong, subparallel, piceous-black, the legs rufous; head rather coarsely and muricately, evenly but not very densely punctate; prothorax not quite twice as wide as long, widest at the middle, feebly narrowed and distinctly sinuate at apex, the sides subevenly, rather strongly arcuate, becoming straight or feebly sinuate anteriorly, with the angles somewhat acutely prominent; surface somewhat shining, not very finely or closely, muricately punctate, the punctures rather coarse and almost in longitudinal contact at a short distance from the sides, then well separated and equally coarse to the side margins; scutellum punctate in anterior half; elytra fully one-half longer than wide, barely three times as long as the prothorax and slightly wider, very obtusely rounded at apex, parallel, the sides nearly straight, the humeral callus pronounced; surface shining, with even, unimpressed series of rather coarse, not very close-set or distinctly muricate punctures, the intervals with almost even series of similar but slightly less coarse punctures; abdomen not very finely, feebly, sparsely punctate. Length 4.4 mm.; width 1.88 mm. New Mexico (Las Cruces). .....**famelica** n. sp.

Form much stouter, convex, polished throughout, dark castaneous, the abdomen rufo-piceous, the legs bright rufous; head with rather small, non-muricate and notably sparser punctures, shining; prothorax very nearly twice as wide as long, distinctly narrowed but rather feebly sinuate at apex, the sides strongly but unevenly rounded, strongly converging and straight toward both the anterior and posterior angles, the former not prominent and obviously obtuse; surface polished, with rather small but deep, perforate, non-muricate and well separated punctures medially, becoming rather coarse and close laterally but still slightly separated and only feebly muricate near the margins; elytra oval, less than one-half longer than wide, more than three times as long as the prothorax and, behind the middle, slightly wider, the sides broadly arcuate, the apex very obtusely ogival; punctures coarse, not very close-set, evenly serial, becoming very coarse laterally, especially toward base, the interstitial punctures only slightly less coarse and subevenly serial but more remotely spaced; abdomen finely, sparsely punctate. Length 5.0 mm.; width 2.22 mm. New Mexico (Deming), — H. F. Wickham. **lustrella** n. sp.

23 — Body oblong-oval, not very stout, convex; head with moderately coarse, close and subscabrous punctures, the median parts of the occiput more sparsely punctate; prothorax shining, four-fifths wider than long, moderately narrowed and sinuate at apex,

widest rather behind the middle, the sides subevenly, rather strongly arcuate but becoming somewhat abruptly converging and straight near the basal angles, the punctures rather small, sparse and submuricate medially, where there is a very fine, faint median raised line not extending to base or apex, rather coarse, subcontiguous and scabrous laterally, the lateral margin very fine; elytra oval, fully one-half longer than wide, rather more than three times as long as the prothorax and slightly wider, gradually and not very obtusely rounded behind, parallel, the sides broadly arcuate, widest near the middle, the humeri not at all exposed at base, the punctures rather coarse, especially toward base, somewhat close-set in subeven and unimpressed series, the interstitial series regular but with rather less coarse and widely spaced punctures; abdomen polished, feebly rugulose and rather sparsely punctulate. Length 4.8 mm.; width 2.15 mm. New Mexico (Albuquerque), — H. F. Wickham.....**pavida** n. sp.

Body oval, convex, stouter, the head with moderate, scarcely scabrous and rather distinctly separated punctures; prothorax much shorter and more transverse, twice as wide as long, distinctly narrowed and sinuate at apex, the sides subevenly and rather strongly arcuate, becoming straight or subsinuate for a much shorter distance immediately before the basal angles; surface with similar trace of a fine partial elevated median line, the punctures very fine, rather sparse and feeble medially, gradually coarse laterally, becoming almost contiguous and scabrous near the sides, which are much more broadly reflexed than in either the preceding or following species; elytra two-fifths longer than wide, fully three and one-half times as long as the prothorax and distinctly wider, the apex gradually and obtusely ogival, the sides arcuate, the humeri slightly exposed at base, the series unimpressed, somewhat uneven, composed of close-set punctures which are very feeble and not very large, flexed outwardly toward base, with gradually much coarser and deeper punctures, the interstitial punctures forming very irregular single series, smaller in size and more widely separated; abdomen very convex, finely, sparsely punctate. Length 5.3 mm.; width 2.4 mm. Arizona (Winslow), — H. F. Wickham . ...**ovalis** n. sp.

Body elongate-oval, convex, much narrower than in the two preceding; head rather closely and coarsely, muricately punctate; prothorax four-fifths wider than long, but slightly narrowed though strongly sinuate at apex, the sides subparallel, almost evenly and very moderately arcuate, much less rounded than in the two preceding species, the lateral edges only very finely reflexed but distinctly and unevenly serrulate; punctures rather small but distinct, submuricate and well separated, becoming gradually larger and more rugose laterally and very coarse and closely scabrous near the sides; elytra very elongate, three-fifths longer than wide, three and three-fourths times longer than the prothorax and slightly wider, gradually obtuse and subparabolic at tip, widest at about

the middle, with the sides broadly arcuate, the humeri scarcely at all exposed at base; punctuation nearly as in *ovalis*, the serial punctures becoming very coarse and close-set toward base but gradually much smaller and very feeble posteriorly: abdomen finely, sparsely punctate. Length 4.7 mm.; width 2.0 mm. Arizona (Holbrook), — H. F. Wickham..... **inops** n. sp.

Body oblong-oval, stout, polished, pale rufo-castaneous; head moderate, polished, rather coarsely, sparsely punctate, the sinuations feeble, the epistoma very feebly produced, broadly truncate; prothorax scarcely twice as wide as long, the apex evidently narrower than the base, the sides rather strongly arcuate, more converging and straight, with the edge serrulate anteriorly, not sinuate before the basal angles, which are obtuse and not at all prominent, the punctures sparse, moderately fine, becoming rather coarse and only slightly muricate, close though not crowded laterally, the edge very finely and feebly reflexed; scutellum moderate, slightly transverse; elytra a little more than one-half longer than wide, gradually parabolic in apical two-fifths, nearly three and one-half times as long as the prothorax but only very slightly wider, the sides feebly arcuate, the humeri not exposed at base; punctures coarse, especially toward the sides, rather close-set in even and unimpressed series throughout, scarcely at all muricate, the interstitial punctures widely spaced in very uneven single series; abdomen finely, sparsely punctate medially; anterior tibiæ short and thick, with the outer spur very strong and scarcely oblique, the outer edge obtusely serrate, the serrules alternating with short thick spinules. Length 5.4 mm.; width 2.4 mm. Arizona (Riverside), — H. F. Wickham.....**aliena** n. sp.

24 — Form elongate-oval, convex, polished, pale testaceous throughout; head rather finely, submuricately and not densely punctate, the sides feebly arcuate as well as converging; prothorax twice as wide as long (♀) or slightly less (♂), strongly narrowed from base to apex, with the sides evenly arcuate (♂) or more abruptly converging and subsinuate near the base (♀), evidently serrulate, the apex deeply sinuate, the punctures sparse, moderately fine and scarcely muricate and with a partial impunctate median line medially, becoming larger and more scabrous but still well separated toward the sides; elytra rather less than one-half longer than wide, between three and four times as long as the prothorax and evidently wider, obtusely ogival at tip, the sides broadly arcuate, the humeri not exposed at base, the punctures shallow, only moderately coarse, arranged in even, unimpressed and close-set series, not notably coarser toward base, the interstitial punctures only slightly smaller though more widely spaced in nearly even series; abdomen minutely, remotely punctulate medially. Length 4.3–4.8 mm.; width 1.8–2.15 mm. Texas (El Paso), — G. W. Dunn..... .....**serrata** Lec.

Form stouter, scarcely so convex, oblong-oval, shining, darker testaceous throughout; head as in *serrata*, finely, sparsely punctate

except, as usual, anteriorly, where the punctures are dense and rugose; prothorax very short, rather more than twice as wide as long, strongly narrowed and sinuate at tip, the sides almost evenly, rather strongly arcuate and coarsely crenulate, the apical angles somewhat acute and subprominent, sculptured nearly as in *serrata*, the punctures medially finer and more evidently muricate, coarse and well separated laterally; surface with a deep impressed line along the basal margin throughout the width as in *aspera;* elytra oblong, more parallel and with straighter sides than in *serrata* and with the humeri evidently exposed at base, one-half longer than wide, nearly four times as long as the prothorax and almost a third wider, obtusely ogival posteriorly, the series unimpressed, composed of punctures which are rather coarse, deep and so close as to become irregularly crowded, the single nearly even series of the intervals being much less strongly and very remotely punctured; abdomen sparsely and extremely minutely punctulate medially, very convex. Length 5.0 mm.; width 2.28 mm. Texas (Del Rio), — H. F. Wickham.....**blanda** n. sp.

If the true *Eurymetopon*, of Eschscholtz, is really represented in the material serving as the basis of this revision, it is more likely to be the present genus than any other, for, although invariably having well developed eyes, a distinct supra-orbital carina and slender, non-incrassate antennal shaft, it has a good many of the characters assigned by Lacordaire to *Eurymetopon rufipes*, such as a prothorax decidedly narrower than the elytra as a rule, the latter being frequently feebly sulcate and strongly muricate, or what might be termed rugulose. I however hesitate to identify *Telabis* as the true *Eurymetopon* for the present.

The species described above as *histrica* bears a rather deceptive resemblance to *Metoponium*, by reason of its unusually coarse sculpture and almost obsolete frontal emarginations, but these punctures have the same general character as in the more normal species of *Telabis*, and the basal joint of the hind tarsi is quite as greatly elongated. *Mimetica* resembles *crassula* and allies closely in general form, but I cannot reconcile the very decided difference in elytral sculpture; the type is a female and is compared with the same sex of *crassula;* the forms allied to *crassula* are somewhat confusing. In the female the prothorax is frequently either smaller or more transverse than in the male and the elytral sculpture is sometimes a little stronger. In the rather prominent epistoma, *lobifrons*, *incisa* and several others, take very much the same position in *Telabis* that *piceus* and some

others occupy in *Hylocrinus;* they are rather singular exceptions, betraying a tendency, even in the present tribe, toward the development of the prominent epistomal lobe, so extremely prevalent elsewhere among those Tentyriinæ having a large mentum. The sides of the elytra usually have some erect and widely spaced setæ, longer toward base, and particularly developed in *incisa* and a few other species. The species described by Champion in the "Biologia," under the name *Eurymetopon brevicolle*, belongs to this genus in the neighborhood of *longipennis*.

Cryptadius Lec.

In general habitus this genus, by reason of its broadly oval form and strongly, anteriorly narrowed prothorax with obtusely rounded basal angles, is quite different from the two which precede and it is undoubtedly valid. LeConte originally described the clypeus as produced and truncate, which might easily be misleading as it is not as evidently produced as in several species of *Telabis*, although somewhat distinctly defined by the two small feeble emarginations as in that genus; it also resembles *Telabis* in the generally muricate character of the sculpture and in the structure of the hind tarsi, where the basal joint does not however so greatly exceed the fourth in length. The species are not numerous and the four before me are confined, as far as known, to the maritime regions of southern California, though probably extending also into the adjacent parts of Lower California; they may be defined as follows: —

Hind tibiæ feebly arcuate to almost straight; body black or piceous-black in color.....2

Hind tibiæ strongly arcuate; body ferruginous throughout, less broadly oval and more acutely pointed behind.....5

2 — Pronotal punctures close and more or less longitudinally elongated or strigose medially.....3

Pronotal punctures fine, sparse and simple toward the middle.....4

3 — Body broadly oval, the sides of the prothorax strongly converging, the scutellum projecting behind the raised basal margin of the elytra. Convex, alutaceous, black, the legs rufous; head broad, coarsely, closely punctato-scabrous, the eyes moderate, prominent, the sides before them strongly converging and slightly arcuate, the epistoma obviously advanced, with very oblique sides and truncate apex; prothorax less transverse than in any other species,

only slightly more than twice as wide as long, the apex scarcely more than two-thirds as wide as the base, deeply sinuate, the angles right and not at all rounded, the sides broadly arcuate, becoming straight toward apex, the punctures longitudinally coalescent throughout, small medially, very coarse laterally; elytra about a fifth longer than wide, barely three times as long as the prothorax but fully a fourth wider, the sides arcuate, the humeri rounded and apex acutely ogival, the flanks vertical, with an elongate impression at the side margin near basal third, the punctures fine, feeble, irregular, muricate, coarsely so laterally; abdomen finely, sparsely punctate. Length 7.0 mm.; width 3.8 mm. California (San Diego).....**inflatus** Lec.

Body less broadly and more oblong-oval, the prothorax less narrowed at apex and very much shorter and more transverse. Convex, black or piceous-black, the head and prothorax generally slightly, the under surface and legs more distinctly, rufescent, alutaceous; head coarsely, densely punctato-scabrous, the sides strongly converging and straight or virtually so, the epistoma only very feebly prominent; prothorax two and one-half times as wide as long, the sinuate apex three-fourths as wide as the base, otherwise in form and sculpture as in *inflatus;* elytra a fifth longer than wide, evidently more than three times as long as the prothorax and but little wider, rather acutely ogival at tip, the sides less arcuate than in *inflatus*, similarly sculptured, the impression at the side margin very much smaller, less elongate and feebler; abdomen similarly finely, sparsely punctured, the third segment of the female with a rounded impression at apex at each side, almost midway between the middle and the margin, the fifth very faintly biimpressed or slightly tumid along the median line. Length 4.7–6.5 mm.; width 2.62–3.42 mm. California (near San Diego and at Redondo Beach).....**oviformis** n. sp.

4 — Oval but rather more oblong than in *oviformis*, convex, alutaceous but with the elytra more polished than usual, black, rufopiceous anteriorly and beneath, the legs brighter rufous; head as in *oviformis* but with coarse and still sparser sculpture; prothorax as in *oviformis* but with the punctures fine, feeble and sparse, the surface more opaque, the sculpture coarse but not so dense and longitudinally plicatulose laterally; elytra in outline nearly as in *oviformis* but relatively less exceeding the prothorax in width, comparing the male types, in fact only slightly wider than that part, more strongly, though not more closely, and more muricately punctate, the sculpture becoming particularly rough toward the sides; abdomen minutely, sparsely punctate medially. Length 5.2–5.9 mm.; width 2.8–3.15 mm. California (Los Angeles Co.). **punctipennis** n. sp.

5 — Form narrower and more elongate-oval than in *inflatus*, convex, alutaceous above, bright rufous and shining beneath; head transverse, coarsely, densely punctato-scabrous, the epistoma distinctly

produced, broadly truncate, the converging sides before the eyes rather strongly arcuate; prothorax about two and a third times as wide as long, otherwise as in *inflatus* and quite as densely sculptured throughout; elytra fully a fourth longer than wide, more than three times as long as the prothorax and but slightly though evidently wider, unusually acutely and gradually ogival at tip, the sides feebly arcuate, rounding as usual at base, the punctures fine, irregular and well separated but more strongly muricate than usual, becoming more closely aggregated into obscure longitudinal and very faintly elevated lines laterally, the pleural impression subobsolete; abdominal segments narrowly margined with black at apex, the impressions of the third segment in the female very faint and subobsolete. Length 6.5 mm.; width 3.28 mm. California ..... **curvipes** n. sp.

It is assumed that the small impressions subequally trisecting the width of the third abdominal segment at apex, visible in some individuals, pertain to the female, for the reason that my only specimen having the intromittent spicule protruded is devoid of these impressions. Of *oviformis* I have a very large series, exhibiting but little variability, and, although the species adhere closely to a common type of structure throughout, I am therefore somewhat confident of their validity as expressed above.

Emmenides n. gen.

In general facies this genus is not unremindful of *Metoponium*, but with the fine sculpture of *Telabis*. The frontal margin is entire and very broadly arcuato-truncate, the mandibles feebly cleft at tip, flat above, with a broad flat ridge externally at base, and the mentum has the usual small apical emargination. The antennæ are long and slender, the eyes rather large and notably prominent, the scutellum short but distinct and strongly transverse, and the hind tarsi are shorter than the tibiæ, with the basal joint much longer than the last. The single species is the following: —

Body oblong, parallel, convex, glabrous, shining, rather pale rufo-castaneous throughout, the legs concolorous; head broad, not very coarsely but deeply and closely punctate, the sides much less prominent than the eyes, strongly converging and arcuate, merging gradually into the apical margin; prothorax three-fourths wider than long, much narrower at apex than at base, the sides evenly converging throughout and broadly, evenly arcuate, the apex sinuate, the angles right, not rounded, the side margins

distinctly reflexed and the base broadly, feebly, bisinuately truncate, the punctures fine and sparse, becoming gradually rather coarse, dense and longitudinally confluent toward the sides; elytra three-fifths longer than wide, three times as long as the prothorax and scarcely wider, parallel, the sides scarcely arcuate, the apex gradually and narrowly parabolic, the punctures fine, very sparse, arranged in unimpressed, subeven series, becoming stronger and more close-set laterally, the intervals still more finely, sparsely and confusedly punctate, the sculpture not muricate; abdomen finely, sparsely punctate. Length 8.8 mm.; width 3.68 mm. Lower California (Cape San Lucas) .....**punctatus** Lec.

The metasternum is much shorter than the first ventral, a remarkable character in such an elongate and parallel species of this tribe and probably betokening vestigial or perhaps obsolete hind wings. The singular longitudinal elevation at each side of the elytral suture, very near the apex, is a character common in the Epitragini but unknown in the present tribe except in the present species.

Armalia n. gen.

This genus is allied in any way closely only to *Hylocrinus* and resembles the latter in general facies and sculpture, but the form of the epistoma is very exceptional in the present tribe, being a significant reminder of the usual lobe of the Epitragini. The angulation mentioned in the generic description, although feeble, is readily observed and very constant in both of the species before me. The only Mexican species of *Emmenastus* said by Champion to have the epistoma angularly produced is *constrictus*, but this differs very much in general form and facies from our species. The mandibles in *Armalia* are feebly bifid at tip and toothed above, the tooth of the left mandible feeble, that of the right large, porrect and pointed, grasping and aiding to retract the labrum. The metasternum is much longer than the first ventral, the wings being fully developed, and the base of the prothorax is strongly lobed at the middle. The hind tarsi are slender, much shorter than the tibiæ and have the first joint longer than the fourth. Our two species are as follows: —

Form oblong-elongate, moderately convex, glabrous, feebly alutaceous, the elytra shining, brownish-testaceous, the legs more rufous, the head, prothorax and sterna piceous to blackish; head not very transverse, rather strongly, closely and simply punctate, the eyes large and moderately prominent, the sides converging and arcuate,

the frontal margin without trace of emarginations; prothorax nearly four-fifths wider than long, slightly wider behind the middle than at base, strongly narrowed anteriorly and deeply sinuate, with rather acute and prominent angles, the sides almost evenly and broadly arcuate; punctures only moderate in size but strong and rather close-set, becoming only slightly larger but deeper and coalescent laterally, each puncture with an exceedingly minute yellow seta; scutellum moderate; elytra but little more than one-half longer than wide, about three and one-half times as long as the prothorax but only very slightly wider, evenly, obtusely ogival in apical third, the sides parallel and nearly straight; punctures in even impressed series, continuing to the apex and becoming coarse and approximate laterally, the interstitial punctures very minute, sparse and more or less confused; abdomen finely but distinctly, sparsely punctate. Length 7.2 mm.; width 3.2 mm. Texas .....**texanus** Lec.

Form narrower, moderately convex, slightly alutaceous, deep black in color, the legs dark rufous; head as in *texanus* but rather less coarsely or closely punctate; prothorax formed nearly as in *texanus* but rather less transverse and with the punctures medially rather finer, becoming much coarser and close-set laterally but not as dense as in *texanus;* scutellum small, subparallel, truncate; elytra more elongate, two-thirds longer than wide, similarly about three and one-half times as long as the prothorax but scarcely wider, more gradually and acutely ogival in about apical third, the sides parallel and nearly straight, the sculpture similar but with the serial punctures less coarse laterally and the eighth stria less impressed and less coarsely punctured toward base than in that species. Length 6.6–7.7 mm.; width 2.65–3.0 mm. Texas (Brownsville),— H. F. Wickham.....**angularis** n. sp.

The impression of the eighth stria toward base, it being there more coarsely and closely punctured, is a rather distinct feature in this, as well as in some species of the following genus. The descriptions of *texanus* and *angularis* given above are both drawn from the male, but there are no striking secondary sexual characters observable, except that the head in the female is slightly smaller than in the male.

Hylocrinus n. gen.

While this genus is readily distinguishable from *Armalia* by the unlobed epistoma and simple or much less strongly toothed right mandible, it resembles it closely in the elongate form of the body, in its slender antennæ, feebly bifid apex of the mandibles, well developed and moderately prominent eyes, in hav-

ing the basal joint of the hind tarsi much longer than the fourth and the base of the prothorax lobed in the middle. It is a composite genus and may be resolved into the three following subgeneric groups : —

Mandibles subhorizontal, feebly toothed on the upper surface, the right tooth slightly the more developed, as usual, and feebly clasping the labrum ; frontal margin varying from broadly and feebly arcuate to sinuato-truncate ; mentum transverse, broadly rounded at apex, with a small broadly sinuate apical emargination ; body very narrow and elongate as a rule, the sculpture usually rather coarse : metasternum but slightly longer than the first ventral...**Hylocrinus**

Mandibles shorter, stouter and more deflexed, convex above but not toothed, folding wholly beneath the labrum ; body broader in form ; metasternum much longer than the first ventral.....2

2 — Mentum less transverse than in *Hylocrinus*, biobliquely rectilinear at apex, the apical angle abruptly and sinuously emarginate ; frontal margin feebly biemarginate, the epistoma generally somewhat advanced and always broadly sinuate.....**Locrodes**

Mentum shorter, transverse, the apex broadly arcuate, without trace of the small emargination so constant elsewhere in the tribe ; frontal margin arcuate, not biemarginate, somewhat narrowly sinuate at the middle.....**Paravius**

The hind wings appear to be fully developed in the last two of these groups but not in the first, the metasternum being decidedly longer than the first ventral segment in the former but not so distinctly in the latter. The species may be described as follows : —

Hylocrinus in sp.

Frontal margin perfectly even throughout, without trace of minute emarginations at the ends of the oblique sutures 2

Frontal margin broadly, feebly sinuato-truncate, sometimes biemarginate.....6

2 — Frontal margin broadly, feebly arcuate ; species confined to southern California and western Arizona ; body very elongate, narrow and moderately convex 3

Frontal margin transversely rectilinear ; body less elongate ; species more eastern in range.....5

3 — Punctures of the pronotum strong throughout, becoming very gradually dense, coalescent and forming long parallel rugæ toward the sides, moderately close toward the middle. Body parallel, only moderately convex, shining, piceous-black, the under surface, legs and elytral suture more or less rufous ; head rather closely and strongly punctured, the sides rather feebly converging, strongly arcuate, merging into the median parts through very broadly

rounded angles; prothorax four-fifths wider than long, subparallel, with feebly rounded sides, becoming more rounded and converging apically, the angles obtuse, the apex moderately sinuate, the surface feebly and indefinitely impressed at the middle before the base; scutellum moderate, constricted at base; elytra fully three-fourths longer than wide, three and one-half times as long as the prothorax and scarcely at all wider, parallel and nearly straight at the sides, gradually ogival in apical two-fifths, with regular unimpressed series of rather coarse, deep, non-muricate punctures, the interstitial punctures very fine, feeble and forming uneven single series; abdomen feebly rugulose, finely and sparsely punctured. Length 6.2 mm.; width 2.28–2.35 mm. Arizona. **tenuis** n. sp.

Punctures of the pronotum more or less fine and notably sparse, becoming very abruptly coarser, dense and forming long parallel rugæ toward the sides 4

4 — Form parallel, stouter than in *tenuis*, shining, piceous-black, the under surface and legs dark piceo-rufous; head nearly as in *tenuis* but rather more coarsely, densely sculptured; prothorax very moderately transverse, about three-fourths wider than long and not much less than a third as long as the elytra, narrowed gradually toward the sinuate apex, with the sides subevenly and rather strongly arcuate, the surface with a somewhat deep indentation before the middle of the base; scutellum small; elytra one-half to two-thirds longer than wide, very slightly wider than the prothorax, obtusely ogival in apical third, sculptured nearly as in *tenuis*, the serial punctures very close-set, those of the intervals in subeven series and somewhat minute and feeble; abdomen similar. Length 5.2–6.3 mm.; width 2.0–2.45 mm. California (San Diego)..... **longulus** Lec.

Form narrow but more elongate-oval than in *longulus* and paler in color, pale piceo-castaneous, the suture suffusedly paler, rufous, the under surface and legs red; surface shining; head nearly as in *longulus*, the prothorax shorter and more transverse, about four-fifths wider than long, rather more strongly narrowed at apex, with the sides subevenly but less strongly arcuate, otherwise similar; elytra one-half to three-fifths longer than wide, three and one-half times as long as the prothorax and but slightly wider, evenly and more acutely ogival at apex and with the sides rather more evidently arcuate, the sculpture nearly similar; tarsi very slender; metasternum equal in length to the first ventral. Length 5.2–6.2 mm.; width 2.1–2.42 mm. California (Los Angeles and San Diego Cos.).....**filitarsis** n. sp.

5 — Body decidedly shorter and relatively stouter than in any of the preceding species, shining, convex, rather dark and uniform rufotestaceous throughout; head not very coarsely or closely punctatostrigose, the sides moderately converging and not very strongly arcuate, the angles more distinct and less broadly rounded than in

the preceding species; prothorax four-fifths wider than long, very much narrowed at apex, with the sides subevenly and rather strongly arcuate, widest somewhat behind the middle and broadly impressed before the basal margin almost throughout the width, the punctures fine and sparse, becoming abruptly coarser, dense and forming long subparallel rugæ laterally; scutellum rather well developed, rounded, transverse, constricted at base; elytra one-half longer than wide, between three and four times as long as the prothorax, and, toward base, but little wider though distinctly wider and subinflated near apical third, the apex thence obtusely ogival; punctures only moderately coarse or close-set, perforate, in even unimpressed series, the interstitial punctures feeble and minute, forming irregular single series; abdomen finely, feebly rugulose and minutely, sparsely punctate. Length 5.8 mm.; width 2.72 mm. Texas.....**breviusculus** n. sp.

6 — Form very narrow, elongate and but moderately convex, the prothorax subparallel, with the apex only just visibly narrower than the base, polished, dark testaceous, the elytra finely vittate along the punctured series with piceous-black; under surface and legs still paler, rufous; head alutaceous, moderately coarsely and not densely punctato-strigose, the sides converging and strongly arcuate, the angles very broadly rounded, the feeble emarginations obvious; prothorax short, four-fifths wider than long, the sides broadly and rather feebly arcuate, the punctures not very fine, deep, rather sparse, becoming somewhat gradually rather coarse, dense and longitudinally plicate toward the sides, the surface impressed before the basal lobe; scutellum small, transverse; elytra about two-thirds longer than wide, between three and four times as long as the prothorax and a little wider posteriorly, where they are slightly wider than at base, obtusely ogival at apex, the sides feebly arcuate, the humeri not exposed, the punctures not very coarse but deep, close-set, forming nearly even and barely impressed series, the interstitial punctures fine, feeble, forming very uneven single series laterally. Length 5.6–5.8 mm.; width 2.25–2.3 mm. Utah (southwestern) and Nevada (Las Vegas).
delicatulus n. sp.

Form somewhat as in *delicatulus* but larger and broader, similarly depressed, shining, dark castaneous, the under surface and legs paler, rufous; head three-fifths to two-thirds as wide as the prothorax, moderately coarsely but not very deeply, closely punctate; eyes large, the sides before them converging and arcuate, the emarginations subobsolete, the frontal margin very feebly sinuato-truncate; prothorax two-thirds wider than long, gradually and distinctly narrowed from base to apex, the sides subevenly and moderately arcuate, the apical angles obtuse and bluntly rounded, the basal right and blunt, the punctures fine and sparse medially, becoming rapidly somewhat coarse, dense and coalescent, forming long fine rugæ in lateral fourth; scutellum moderate, transverse;

elytra very long, fully three-fourths longer than wide, rapidly ogival in apical fourth, rather widest well behind the middle, where they are more than a fifth wider than the prothorax, fully four times as long, the punctures rather small but distinct, only moderately close-set in finely and barely impressed regular series, only slightly larger laterally, the intervals minutely, feebly punctured in very uneven single series throughout; abdomen very minutely, feebly and sparsely punctulate medially. Length 6.5–6.7 mm.; width 2.6 mm. California (San Diego).

depressulus n. sp.

Form more convex, the prothorax very distinctly narrowed at apex...7

7 — Frontal margin perfectly even, not at all biemarginate, the epistoma not at all advanced, with the sinuation scarcely appreciable. Body elongate-oval, shining, brownish-testaceous, the under surface and legs pale, rufous; head rather coarsely punctured, sparsely on the vertex, densely anteriorly as usual, the sides converging, moderately arcuate, the angles rather broadly rounded; prothorax three-fourths wider than long, widest at about basal third, the sides almost evenly arcuate and distinctly converging from base to apex, the latter only moderately sinuate, with the angles rather obtuse, the punctures fine and notably sparse toward the middle, becoming closer and elongate, then still coarser, dense and longitudinally plicate in about lateral fourth, the median impression at base very feeble; elytra two-thirds longer than wide, more than three times as long as the prothorax and evidently wider, gradually rather acutely ogival at apex, the sides broadly and evenly arcuate, not inflated posteriorly, the punctures somewhat coarse, deep, extremely close-set, forming slightly uneven, unimpressed series, the interstitial punctures fine, feeble, not close-set and forming very uneven single series; abdomen finely and feebly rugulose, finely but not very sparsely punctate medially. Length 6.7 mm.; width 2.5 mm. Arizona.....**angustus** Csy.

Frontal margin with two very feeble emarginations, the epistoma feebly but evidently advanced, broadly sinuate at apex; oblique sutures rather deeply impressed.....8

8 — Form elongate-oval, shining, blackish, the elytral suture and fine lines along the elytral intervals toward the suture, under surface and legs dark rufous; head rather coarsely, closely punctate, less coarsely and very densely so and paler in color apically, the sides converging and arcuate; prothorax three-fourths wider than long, the apex deeply sinuate, with the angles rather acute, about four-fifths as wide as the base, the sides evenly converging and broadly, evenly and rather feebly arcuate throughout, the punctures rather small but deep and distinct though sparse in about median third, then gradually becoming very dense, rather coarse and somewhat confluent toward the sides; scutellum moderate, transverse, narrowed at base; elytra two-thirds longer than wide, between three and four times as long as the prothorax and slightly

wider, ogival at tip, the sides broadly arcuate, the punctures only moderately coarse, close-set but shallow in slightly uneven and unimpressed series, the irregular interstitial series fine and still feebler; abdomen finely, sparsely punctured medially. Length 6.4 mm.; width 2.72 mm. California (Mokelumne Hill, Calaveras Co.),— F. E. Blaisdell.....**blaisdelli** n. sp.

Form elongate-oval, rather shining, colored nearly as in *blaisdelli*, the under surface and legs brighter rufous and more polished; head rather coarsely, closely punctured, the sides strongly converging and broadly, evenly arcuate; prothorax rather more than three-fourths wider than long, the apex broadly sinuate and three-fourths as wide as the base, the sides more converging and a little more strongly, subevenly arcuate throughout, the punctures only moderately small, deep and rather close-set, becoming gradually coarser, densely crowded and longitudinally confluent laterally, the surface broadly and feebly impressed before the basal margin, except laterally as in *blaisdelli;* scutellum similar; elytra with rather fine, feeble and very close-set punctures in uneven unimpressed series, becoming coarse very near the base, the interstitial punctures smaller, extremely shallow and rather confused; abdomen highly polished, excessively minutely, sparsely punctulate medially. Length 6.7 mm.; width 2.8 mm. Texas.
cunctans n. sp.

Locrodes n. subgen.

Sculpture more or less strong and closer. Southern California.....2

Sculpture extremely fine, sparse and feeble. Utah and the Great Basin.....3

2 — Body oblong, moderately convex, alutaceous, black, the under surface and legs more or less rufo-piceous; head not coarsely but rather closely punctate, the frontal margin biemarginate, the epistoma notably advancing and broadly sinuato-truncate, the sides before the eyes moderately converging and evenly, moderately arcuate to the fine but distinct oblique sutures; prothorax short, nearly twice as wide as long, the moderately sinuate apex very much narrower than the base, the sides evenly and rather strongly arcuate, the punctures small but distinct, moderately sparse throughout, except in lateral fifth or sixth, where they become coarse and confluent; scutellum moderate, parallel at the sides; elytra but little more than one-half longer than wide, three and one-half times as long as the prothorax and scarcely wider, evenly ogival toward tip, the sides feebly arcuate, more strongly at base, the humeri not exposed; punctures rather small but distinct, moderately close-set in somewhat even, unimpressed series, the interstitial punctures minute and feeble, widely spaced in subeven single series; abdomen polished, minutely, sparsely punctate medially. Length 5.5 mm.; width 2.28 mm. California (San Bernardino Co.).....**piceus** Csy.

Body oblong, parallel, more elongate, rather convex, subalutaceous, piceous-black, the under surface dark, the legs paler, rufous; head not very coarsely but deeply and closely punctured, the frontal margin not at all biemarginate, the oblique sutures subobsolete, the sides very strongly converging, evenly and rather feebly arcuate, the sinuato-truncate apex unusually contracted, only about half as wide as the width at the eyes; prothorax less transverse, four-fifths wider than long, the deeply sinuate apex only slightly narrower than the base, the sides evenly and rather strongly arcuate, the punctures not very small, deep and rather close-set, becoming gradually close, coarser and unevenly, longitudinally confluent laterally; scutellum well developed, shining, impunctate, rounded behind; elytra in form nearly as in *piceus*, but with the punctures coarse, deep and close-set in subeven and evidently impressed series, the interstitial punctures fine but distinct, arranged in rather uneven single series; abdomen finely but deeply, less sparsely punctate medially, the first segment in great part coarsely so laterally. Length 7.0 mm.; width 2.8 mm. California (near San Diego)..... .....**oblongulus** n. sp.

3 — Prothorax widest before the base; scutellum well developed, about a sixth as wide as the base of a single elytron 4

Prothorax widest at the base; scutellum variable..... 5

4 — Oblong-oval, moderately convex, alutaceous, rather dark red-brown, the legs but little paler and more rufous; head very finely, sparsely punctate, less finely, densely so anteriorly, the sides strongly converging, evenly and strongly arcuate, the epistoma broadly sinuato-truncate, the sutures impressed posteriorly but obsolete toward the edge; prothorax short, nearly twice as wide as long, strongly narrowed and sinuate at apex, with the angles acute but not prominent, widest at two-fifths from the base, where the sides are strongly arcuate, becoming feebly converging basally and strongly and much less arcuate toward apex; punctures minute and rather sparse, becoming gradually larger and closer but not very coarse or coalescent laterally; elytra three-fourths longer than wide, between three and four times as long as the prothorax but not wider, obtusely ogival toward tip, the sides very slightly arcuate, the punctures very fine, close-set in feebly and finely impressed, slightly uneven series, the intervals extremely minutely, sparsely and unevenly punctulate. Length 7.0 mm.; width 2.8 mm. Utah (Great Salt Lake).....**laborans** n. sp.

Oblong-oval, rather more convex, the elytra strongly shining, the anterior parts slightly alutaceous, pale brownish-testaceous throughout; head finely but more strongly and less sparsely punctate than in *laborans* but otherwise nearly similar; prothorax less transverse, three-fourths or more wider than long, narrowed at the sinuate apex, scarcely visibly wider at basal third than at base, the sides broadly and more evenly arcuate, the punctures rather less fine but nearly as sparse, becoming similarly larger, closer and

subcoalescent laterally; elytra nearly four-fifths longer than wide, between three and four times as long as the prothorax and slightly wider, the punctures minute, rather feeble, close-set in irregular and wholly unimpressed series, the confused punctures of the intervals still more minute and sparse. Length 6.8–7.7 mm.; width 2.7–3.2 mm. Utah (Great Salt Lake).....**brunnescens** n. sp.

5 — Form oblong-oval, moderately convex, alutaceous, castaneous, the under surface piceo-rufous, the legs slightly paler; head minutely, sparsely punctate, densely so anteriorly, the frontal margin broadly sinuato-truncate, the sides strongly converging and evenly arcuate, the oblique sutures distinct throughout their extent; prothorax nearly four-fifths wider than long, only moderately narrowed and broadly sinuate at apex, the latter four-fifths as wide as the base, widest just before the basal angles, the sides evenly, broadly arcuate and moderately converging to the apex, the punctures minute and sparse, becoming gradually coarser and close, with the surface rugulose laterally as in the two preceding species; scutellum small, smooth, parallel, but little wider than long and about an eighth or ninth as wide as the base of an elytron; elytra as in *brunnescens*, with unimpressed and but slightly irregular series of extremely minute, not very close-set punctures, those of the intervals still more minute, sparser and irregularly uniseriate; abdomen shining, minutely, sparsely punctulate and feebly rugulose. Length 7.3 mm.; width 3.0 mm. Utah (Stockton),— H. F. Wickham ....**fraternus** n. sp.

Form oblong-oval, slightly stouter, rather more shining, piceous-black, the under surface and legs dark piceo-rufous; head nearly similar but with the oblique sutures more obliterated toward the margin and the minute punctures rather stronger; prothorax less transverse, about three-fourths wider than long and very much more narrowed from base to apex, widest at base, the sides evenly converging, evenly and still more feebly arcuate, the apex sinuate, about two-thirds as wide as the base, the sculpture nearly similar; scutellum much larger, rather more than a sixth as wide as the base of an elytron; elytra rather less elongate, more obtusely rounded at apex and more distinctly wider than the prothorax, almost similarly and extremely feebly sculptured, except that the very minute serial punctures are rather more approximate; abdomen nearly similar. Length 6.8–7.1 mm.; width 2.8–3.18 mm. Utah (Stockton).....**umbrosus** n. sp.

Paravius n. subgen.

Form oblong, parallel, rather feebly convex, polished, castaneous, the under surface and legs rufous; head rather coarsely, closely and subrugosely punctate, the eyes unusually prominent, the sides before them strongly converging and evenly, moderately arcuate, the apex unusually deeply sinuate and only about half the width at the eyes, the oblique sutures feeble, scarcely attaining the mar-

gin, which is not at all biemarginate; prothorax fully four-fifths wider than long, only moderately narrowed and deeply sinuate at apex, with the angles right, the sides evenly, moderately arcuate, with the edges notably reflexed; disk widest behind the middle, rather coarsely, deeply and moderately closely punctate, the punctures gradually but only slightly coarser though very dense laterally, forming long and interlacing longitudinal rugæ; scutellum moderate, constricted at base, obtusely angulate at tip; elytra three-fifths longer than wide, between three and four times as long as the prothorax but not evidently wider, slightly dilated posteriorly, gradually and rather obtusely ogival at apex, with finely and feebly impressed series of somewhat coarse, deep and close-set punctures, those of the intervals much smaller but distinct and unevenly uniserial; abdomen extremely minutely, sparsely punctate medially, highly polished. Length 6.25 mm.; width 2.65 mm. Lower California.....**marginatus** Csy.

In the four species of *Locrodes* from Utah, which form a natural group, the secondary sexual characters become interesting, especially those of the female, to which sex these singular characters seem to be confined in various parts of the Tentyriinæ, such as some Epitragids and in *Telabis punctulata*, in opposition to a rather general rule in the Coleoptera and as shown in the present subfamily in *Triorophus* and some other genera. All the species of the group referred to are defined above from the female, where the last dorsal segment, normally covered by the elytra, has at apex a very deep abrupt median emargination, from the bottom of which projects posteriorly an elongate, rapidly pointed and densely setose lobe, the last ventral having at the middle of its fine reflexed margin a very small abrupt and rounded sinus. In the male the last dorsal is simply subtruncate at tip, but the last ventral has a feebler and broader sinus, slightly protuberant at its middle and less sharply limited at its sides than in the female, this community of modification of the last ventral to both sexes reminding us of the asexual excavation in the Zopherini and Nosodermini. The setose lobe of the female is rather constant in form in three of the four species defined above, but in *laborans* it becomes broader. LeConte described *longulus* as apterous, but this is evidently not wholly true, although the metasternum is not as long as in the last two subgenera or in *Armalia;* the hind wings are in fact much abbreviated, as in such Mexican species as *tenebrosus* Champ.

Emmenastrichus Horn.

In this genus the body is oblong, parallel, moderately convex, coarsely sculptured and pubescent, with the head very short and broad, the frontal margin even and concealing most of the mouth parts from above, the mandibles being small, stout, rapidly narrowed and deflexed toward tip, with the apex very feebly bifid. The left mandible is broadly ridged externally above, but not evidently toothed, and the right has a very large pointed porrect dorsal tooth, which does not seem to clasp the labrum, although the latter is very strongly retractile. The mentum is moderately transverse, biobliquely rectilinear at apex, with an unusually broad and feebly rounded apical sinus, rather more than a third as wide as the maximum width of the mentum. The eyes are moderate in size and in prominence. The tarsi are rather stout, the posterior much shorter than the tibiæ, with the basal joint slightly shorter, as well as decidedly thicker, than the fourth. The wings are probably aborted, at least to some extent, the metasternum being evidently shorter than the first ventral, notwithstanding the elongate form of the body. The rather long curved hairs of the upper surface are borne only by the interstitial punctures, the coarse serial punctures bearing each from its anterior margin merely an infinitesimal seta, only visible under high power. The type of the genus is the following: —

Oblong, parallel, rather shining, brownish-black above, black beneath, with the legs rufous; head very broadly, rectilinearly truncate, the sides nearly as prominent as the eyes, short, joining the apex through a strong even arcuation and becoming parallel toward the eyes, the punctures coarse, deep, simple, circular and somewhat separated; prothorax parallel, sparsely pubescent, scarcely three-fourths wider than long, the sides evenly and moderately arcuate, the broadly sinuate apex but very little narrower than the base, the side margins rather strongly reflexed; punctures coarse, deep, slightly separated, becoming still coarser and subcoalescent near the sides, the basal margin transverse, extremely feebly and broadly lobed toward the middle; scutellum moderate; elytra three-fifths longer than wide, barely three times as long as the prothorax and scarcely as wide, gradually acutely ogival at tip, the sides parallel and very feebly arcuate; punctures very coarse, perforate, simple, moderately close-set in series which become impressed toward tip, the intervals with two uneven series of fine

punctures bearing long, suberect, fulvous hairs; abdomen polished, feebly rugulose, rather coarsely but sparsely punctate. Length 8.0 mm.; width 2.8 mm. Lower California (San José del Cabo) ....**cribratus** Horn

Another species, differing apparently in its slightly less coarse sculpture and shorter pubescence, was also described by Dr. Horn from the same locality under the name *crosus*. I owe the single specimen of *cribratus* in my cabinet to the kindness of Mr. Charles Fuchs, of San Francisco.

Ditaphronotus n. gen.

The chief peculiarity of this genus is the remarkable excavations at the base of the pronotum, with which no analogy can be found in the subfamily, except perhaps in the still more extraordinary cavity characterizing *Dacoderus*. These crevasses, in the typical forms, are right-angled in shape, extending longitudinally to the basal margin and then along the latter toward the middle for a short distance and are very deep. With this singular character we have also another, rather exceptional in the subfamily, formed by the complete absence of the raised basal margin of the elytra, the acute line delimiting the epipleuræ being simply turned inward for a short distance at the humeri, and, perhaps correlated to some extent with this character, there is an abrupt basal abbreviation of the sixth to ninth series of punctures. The basal joint of the hind tarsi is unusually elongate, almost equaling the remaining three joints combined, and all the tarsi are clothed beneath with very stiff and subdecumbent spiculiform hairs. The eyes are prominent, moderately emarginate, the frontal margin evenly arcuato-truncate from a vertical viewpoint, but with the median part deflexed, forming a very feeble lobe when viewed longitudinally. The mandibles are very stout, bifid at tip, the left with a very obtuse dorsal tooth, the right with a large pointed and porrect dentiform projection on the upper surface, clasping the labrum. The metasternum in the typical species is a little shorter than the first ventral segment and the hind wings are probably vestigial. A typical species may be described as follows:—

Form oblong-oval, only moderately convex, glabrous, alutaceous in lustre, more shining beneath, black, picescent beneath, the legs

rufous; head rather coarsely but not densely punctate, the angles very broadly rounded; prothorax more than two-thirds wider than long, widest just behind the middle, the sides strongly and subevenly arcuate, strongly converging apically and basally, the apex sinuate, with rather obtuse angles and nearly four-fifths as wide as the base, which is feebly bisinuate, the angles right and not rounded, the punctures rather small and sparse but irregular, becoming abruptly coarse, close and subconfluent in lateral fourth or fifth, the basal excavations not connected by an impression along the beaded basal margin; scutellum moderate, transverse; elytra two and one-half times as long as the prothorax but not evidently wider, rather acutely ogival at tip, the sides feebly arcuate, the humeri minutely denticulate, the punctures coarse, close-set in ten slightly impressed regular series, including the marginal, the series extending to the apex, six to nine basally abbreviated, the interstitial punctures extremely minute, arranged in single series; under surface coarsely, sparsely punctured, the abdomen minutely so medially. Length 5.4 mm.; width 2.2 mm. Nicaragua (Ometepe).....***championi** n. sp.

Besides this species, the genus will without doubt comprise the Central American *Emmenastus foveicollis*, *confusus* and *lævicollis*, of Champion, the first apparently differing in its greater convexity and the other two in the different form of the prothorax, but the author describes these species as winged, although the figure of *foveicollis* certainly does not give that impression, and I feel confident that the wings are not large enough for flight in *championi*.

Steriphanus n. gen.

About half of the wingless species, heretofore referred to *Emmenastus*, are included in a somewhat heterogeneous group for which the above generic name is suggested. The only character exhibiting any marked instability is that relating to the base of the prothorax, which varies from rectilinearly truncate to strongly bisinuate or medially lobed. I fail to find any other attendant distinguishing structural feature, however, except certain dissimilarities in general habitus. The mandibles have the usual narrowed and deflexed, feebly bifid apex, the left hardly at all toothed above and the right with a small porrect tooth, feebly clasping the labrum. The eyes are moderate and not very prominent, the frontal margin subeven and not biemarginate, the mentum sinuate at apex, the antennæ long

and slender and the hind tarsi slender and filiform, with the basal joint much longer than the fourth. The metasternum is invariably much shorter than the first ventral segment and the body is oval, convex and glabrous. Many Mexican species, some of which were described by Mr. Champion in the "Biologia" under the name *Emmenastus*, will enter this genus, which, with the numerous American species, will prove to be extensive, the various forms being very local in distribution as usual in Sonoran genera. Our species, so far as known at present, are the following: —

Prothorax transversely and rectilinearly truncate at base throughout the width 2

Prothorax subtruncate, sometimes very feebly lobed toward the middle; larger, more or less opaque species, with the prothorax narrowed from base to apex and having but slightly arcuate sides.....8

Prothorax distinctly lobed at the middle of the base or evidently bisinuate 10

2 — Prothorax inflated and more strongly rounded at the sides just behind the middle, thence converging and just visibly arcuate to the obtuse but not rounded basal angles, and still more converging and broadly subsinuate to the apical angles, which are somewhat prominent though slightly blunt. Body obese, strongly convex, polished, piceous-black, the legs bright rufous; head not very coarsely but deeply, not densely punctured, the sides strongly rounded, the apex broadly sinuate; epistoma slightly swollen, paler and more finely, very densely punctate; prothorax not quite twice as wide as long, the apex deeply sinuate and scarcely two-thirds as wide as the base, the punctures rather small but deep, close-set, becoming but little larger but closer, though not confluent, toward the sides; scutellum moderately large, smooth, transverse; elytra two-fifths longer than wide, less than three times as long as the prothorax and not wider, gradually acutely ogival at tip, with unimpressed series of rather coarse, close-set punctures, the intervals wide, finely and confusedly punctured throughout, without trace of series; abdomen feebly rugulose, minutely, sparsely punctate medially. Length 6.7 mm.; width 3.1 mm. Arizona (Holbrook), — H. F. Wickham.

discrepans n. sp.

Prothorax not subprominently inflated behind the middle, the sides moderately converging from base to apex and broadly, subevenly arcuate, the surface strongly shining or polished throughout.....3

3 — Scutellum well developed, strongly transverse 4

Scutellum small or moderate in size, transverse..... 5

4 — Form broadly oval, black, the legs piceo-rufous; head coarsely, rather closely punctate, the feebly tumid epistoma finely and very densely as usual, the sides moderately converging, evenly and moderately arcuate, the apex sinuato-truncate, the eyes moderate and not at all prominent; prothorax three-fourths wider than long, the sinuate apex nearly three-fourths as wide as the base, with the angles not prominent, widest near basal third, the punctures small but deep, rather well separated, becoming but little larger though close and somewhat longitudinally confluent laterally; elytra short, two-fifths longer than wide, between two and three times as long as the prothorax and scarcely wider, gradually obtusely ogival at tip, the sides parallel, broadly arcuate, having unimpressed series of rather small, moderately close punctures, somewhat coarse laterally and basally, the intervals finely, confusedly punctured throughout; abdomen feebly rugulose, with small but strong, somewhat close-set punctures medially, becoming coarse and conspicuous laterally. Length 6.0–6.7 mm.; width 2.8–3.0 mm. Arizona (Peach Springs),—H. F. Wickham.
lustrans n. sp.

Form narrowly oval, strongly convex, rufo-piceous, the anterior parts and under surface dark, the legs pale, rufous; head rather finely but closely, subevenly punctured throughout, the epistoma not much more closely; eyes much larger than in *lustrans* but not very prominent, the sides strongly converging, evenly and very moderately arcuate, the apex feebly sinuate; prothorax two-thirds wider than long, widest at base, the sides feebly and evenly arcuate, the sinuate apex nearly three-fourths as wide as the base, with the angles not prominent but scarcely blunt, the basal angles distinctly and very exceptionally rounded; disk with a fine marginal bead throughout, only interrupted toward the middle of the apex, the punctures moderately small, deep and slightly separated, with a narrow, even and subentire impunctate median line, becoming but little coarser but dense, subrugose and longitudinally confluent laterally; scutellum scarcely less than a fifth as wide as the base of an elytron; elytra nearly similar in form but almost one-half longer than wide, having feebly impressed series of rather coarse, deep, close-set punctures, the intervals extremely finely, sparsely and confusedly punctulate, though tending to irregular single series on some of the intervals; abdomen finely, rather strongly, somewhat sparsely punctulate medially. Length 5.3 mm.; width 2.45 mm. Texas (Laredo).....**nitescens** n. sp.

5 — Color piceous or paler.....6

Color deep black when mature, the legs piceous to blackish.....7

6 — Form rather narrowly oval, strongly convex, very dark piceous, the under surface dark, the legs pale, rufous; head not coarsely but deeply, very closely and subevenly punctate, the eyes moderate, the sides converging and arcuate, the apex sinuato-truncate; prothorax two-thirds wider than long, very slightly wider at basal

third than at base, the sides subevenly and rather strongly arcuate, the basal angles obtuse and slightly blunt; apex moderately sinuate and not less than three-fourths as wide as the base, the punctures strong though fine, well separated, becoming dense and longitudinally confluent, though not much larger, toward the sides; scutellum smooth, broadly rounded, about a sixth as wide as the base of an elytron; elytra nearly one-half longer than wide, about two and one-half times as long as the prothorax but not wider, gradually acutely ogival at tip, the sides parallel and broadly arcuate, the punctures small but deep, rather approximate in very obsoletely impressed series, the intervals very minutely, sparsely and confusedly, but toward the sides more distinctly, punctate, the punctures forming a nearly even series on the alternate intervals of the flanks; abdomen minutely, sparsely punctulate medially. Length 5.3–6.2 mm.; width 2.4–2.65 mm. Arizona (Peach Springs), — H. F. Wickham.....**lubricans** n. sp.

Form elongate-oval but slightly stouter, castaneous or testaceous, the under surface and legs rufous, the abdomen blackish except at the sides and tip; head with rather small but deep, somewhat close-set punctures, the sides less converging and more strongly arcuate than in *lubricans*, the apex more evidently sinuate; prothorax three-fourths to two-thirds wider than long, otherwise nearly similar, except that the sides are less strongly arcuate and the width at basal fourth less evidently greater than at base, the punctures much more close-set medially but less confluent toward the sides; scutellum about an eighth as wide as the base of an elytron; elytra nearly similar in form but more obtusely ogival at tip, similarly punctured but with the slightly irregular series wholly unimpressed; abdomen finely but more strongly and less sparsely punctate medially. Length 5.9–6.7 mm.; width 2.7–2.9 mm. Arizona (Winslow) and Utah (Leeds), — H. F. Wickham.

hilaris n. sp.

Form elongate-oval, convex, pale yellowish-testaceous throughout — possibly somewhat immature; head rather finely but loosely and substrigosely punctured, very densely on the epistoma, the sides moderately converging, evenly and rather strongly arcuate, the apical margin evidently sinuate; prothorax strongly narrowed anteriorly, fully three-fourths wider than long, the deeply sinuate apex but little more than two-thirds as wide as the base, the sides broadly, feebly arcuate basally, becoming subparallel behind the middle, strongly converging anteriorly, becoming broadly and feebly sinuate toward the apical angles, which are however blunt and not prominent, the basal angles very obtuse and somewhat rounded; punctures moderately fine, impressed, strong, rather widely separated, becoming coarse, dense, rugulose and coalescent laterally; scutellum not more than a seventh as wide as an elytral base; elytra two and one-half times as long as the prothorax but not wider, acutely ogival at tip, with just visibly im-

pressed series of rather coarse, not very close-set punctures, the intervals very minutely, sparsely and confusedly punctulate; abdomen with relatively large, strong and only moderately sparse punctures medially. Length 5.7 mm.; width 2.58 mm. Texas (Laredo) ..... **rutilans** n. sp.

7 — Form elongate-oval, convex, deep black throughout, the legs dark piceo-rufous; head finely, rather irregularly but not densely punctate, the sides feebly converging and strongly arcuate, the apex broadly sinuato-truncate; prothorax fully three-fourths wider than long, widest somewhat behind the middle, the sides evenly and rather strongly arcuate from base to apex, the latter deeply sinuate and fully three-fourths as wide as the base, the apical angles right, not prominent, the basal obtuse and somewhat blunt; punctures fine, rounded, slightly separated, becoming very slightly larger, close and more or less coalescent near the sides; scutellum small; elytra one-half longer than wide, not quite three times as long as the prothorax and very slightly wider, parallel and broadly arcuate at the sides, the apex rather abruptly narrowed to the acutely ogival tip, the punctures small, not very close-set in rather disconnected, unimpressed and feebly defined series, becoming only slightly larger laterally, the intervals very minutely, sparsely and confusedly punctate; abdomen finely but rather strongly, moderately sparsely punctate toward the middle. Length 5.7–6.7 mm.; width 2.65–3.0 mm. New Mexico (Gallup, Albuquerque and Magdalena) ..... **convexus** Lec.

Form nearly similar but rather more elongate, similar in color and lustre, the head with fine separated punctures, becoming dense anteriorly; prothorax similar but with the apical angles less blunt and the basal obtuse but not in the least rounded, the punctures quite as fine but sparser, separated by two or three times their own diameters, becoming close but only slightly larger and scarcely at all coalescent laterally; scutellum much more minute, only about an eighth or ninth as wide as an elytral base; elytra similar but somewhat more elongate, the interstitial punctures much more minute, the series thereby rendered more distinct, also being actually more regular and entire, though composed of no larger punctures; abdomen finely though strongly, moderately closely and distinctly punctured medially. Length 6.0 mm.; width 2.75 mm. Locality unrecorded but probably New Mexico. **unicolor** n. sp.

Form stouter, larger, strongly convex, less shining, black, the legs dark rufous; head rather finely, closely punctured, minutely and very densely anteriorly; prothorax short, four-fifths wider than long, the deeply sinuate apex three-fourths as wide as the base, the angles subacute but not prolonged, the sides evenly, rather strongly arcuate, becoming feebly sinuate near the apical angles, the basal obtuse but not rounded; disk slightly wider at basal two-fifths than at base, finely but deeply, closely punctured, less finely,

very densely and subcoalescently so laterally; scutellum as in *convexus*, about a sixth or seventh as wide as an elytral base; elytra nearly as in *convexus*, but, at the middle, much more evidently wider than the prothorax, minutely, rather sparsely, confusedly punctate, more densely and with the surface less shining and rougher laterally, having unimpressed series of punctures which are fine and scarcely distinguishable suturally but rather coarse, close-set, subscabrous and distinct laterally; abdomen rather finely but strongly and somewhat closely punctured medially. Length 7.0 mm.; width 3.18 mm. Arizona (Hardy), — H. F. Wickham..... .....**nigrans** n. sp.

Form rather stout, oval, polished, glabrous, deep black, the legs rufopiceous, the form nearly as in *curtus* but less abbreviated and with the surface more shining; head finely, rather closely punctured, scarcely more finely but more densely anteriorly; prothorax four-fifths wider than long, the deeply sinuate apex much narrowed, but little more than two-thirds as wide as the base, a little wider near basal third than at base, the sides evenly arcuate, more converging and less strongly so anteriorly, the basal angles obtuse and blunt, the apical right and bluntly rounded; surface evenly convex, deeply, closely and not very finely punctate, becoming gradually rather coarsely, densely and subconfluently so laterally, the basal margin perfectly rectilinear throughout; scutellum transverse, broadly rounded behind; elytra two-fifths longer than wide, two and one-half times as long as the prothorax and not at all wider, obtusely ogival at apex, the sides rounding at base to the thoracic angles; surface convex, with subeven, unimpressed, subentire series of moderately coarse, not very close-set punctures throughout the width, much more distinct than in *curtus*, the intervals more finely and confusedly or very unevenly uniseriately punctate; abdomen strongly and closely punctate. Length 5.3–6.0 mm.; width 2.38–2.75 mm. Mexico (Federal District).
*__placidus__ n. sp.

♂ — Integuments feebly shining, strongly alutaceous rather than opaque. Body stout, oblong-oval, somewhat strongly convex, black with a feeble piceous tinge, the under surface and legs obscure rufous; head with close, deep and not very coarse punctures, separated by more than their own diameters, finer and very dense on the epistoma, the sides only feebly converging and strongly arcuate, so that they are slightly more prominent than the eyes, the apex broadly sinuato-truncate, the oblique sutures very distinct throughout; prothorax barely two-thirds wider than long, the apex moderately sinuate and two-thirds as wide as the base, the sides evenly converging and evenly, very feebly arcuate throughout; surface sparsely and extremely minutely punctate, becoming rather abruptly coarsely and closely, though scarcely coalescently so laterally, feebly subexplanate near the hind angles, which are slightly obtuse and blunt; scutellum about a seventh as wide as an elytral

base, shining, rounded behind; elytra three-fifths longer than wide, not quite three times as long as the prothorax and barely wider, parallel, the sides rounding at base, the apex gradually obtusely ogival, the punctures very fine, widely spaced in regular unimpressed series, slightly larger toward the sides, the intervals sparsely, excessively minutely, irregularly punctulate; abdomen feebly rugulose, finely, sparsely punctate. Female having a very shallow rounded sinus at the tip of the last dorsal segment. Length 7.8 mm.; width 3.28 mm. Arizona (Tucson).

alutaceus n. sp.

Integuments densely opaque..... 9

9 — Form elongate-oval, convex, colored as in *alutaceus;* head similar but rather more coarsely and closely punctate, the punctures separated by barely their own diameters; prothorax nearly similar but less narrowed anteriorly, the apex about three-fourths as wide as the base, the basal angles more obtuse and the surface near them more narrowly but more abruptly explanate, the sides more nearly straight than in either of the other species, rounding at base and apex, the punctures less minute, stronger and rather less sparse, becoming still more abruptly coarse, much denser and longitudinally confluent near the sides and also having a narrow impunctate median line, not evident in *alutaceus;* scutellum slightly larger, about a sixth as wide as an elytral base; elytra similar in form but much more evidently wider than the prothorax, the serial punctures larger and deeper, becoming in fact rather coarse toward the sides, the interstitial punctures similar; abdomen similarly rugulose but more strongly punctulate medially. Male having a small and strongly rounded, reflexed and extremely minutely, apically incised lobe at the apex of the last dorsal segment; female not observed. Length 7.2 mm.; width 3.25 mm. Arizona (southeastern parts near Camp Grant).

subopacus Horn

Form elongate-oval but stouter in form, deep black, the under surface and legs dark rufous; head finely but strongly, less closely punctate, the punctures separated by two or three times their own diameters but extremely dense on the epistoma, as in the preceding, the sides rather more converging, evenly and strongly arcuate in the male, more prominent laterally than in the female, the apical margin distinctly sinuate; prothorax nearly as in *subopacus* but larger, less narrowed at apex than in *alutaceus*, the surface near the hind angles only extremely narrowly and obsoletely explanate, the punctures fine but strong, sparse, becoming in similar manner abruptly coarse, dense and more or less confluent near the sides, an impunctate median line not apparent; scutellum well developed as in *subopacus;* elytra nearly similar, shorter in the female than in the male but only just visibly wider than the prothorax in either sex, the serial punctures only moderately small, deep and very distinct, becoming rather coarse laterally,

the interstitial punctures similar; abdomen much less rugulose, minutely, sparsely punctate medially. Female with a deep abrupt sinus, about three times as wide as deep at the apex of the last dorsal segment, the male having the same segment evenly but broadly, subangularly rounded at tip throughout the width. Length 6.2–8.0 mm.; width 3.23–3.5 mm. Arizona (near Tucson).....**peropacus** n. sp.

10 — Elytra elongate, parallel, body deep black, the under surface piceous-black, the legs rufous, the integuments polished; head rather coarsely, not densely but substrigosely punctate, finely, densely so at apex, the sides only feebly converging but strongly arcuate, becoming parallel toward the eyes, the epistoma feebly sinuate; prothorax not quite four-fifths wider than long, widest near the base, where the sides are arcuate, becoming strongly converging and nearly straight thence to the sinuate apex, which is about two-thirds as wide as the base, the basal angles obtuse and distinctly rounded, the punctures fine but strong, sparse, with a partial impunctate median line, rather abruptly coarse, dense and longitudinally confluent toward the sides; basal lobe moderate; scutellum small, a seventh or eighth as wide as an elytral base; elytra one-half longer than wide, or, in the female, a little less, barely as wide in the basal part of the prothorax, gradually narrowly rounded or subogival toward tip, the sides very feebly arcuate; punctures fine, coarse toward the sides, extremely close-set and crowded in virtually unimpressed series, the interstitial punctures extremely sparse and very minute, confused; abdomen minutely, sparsely punctate medially. Length 6.0–7.0 mm.; width 2.4–2.9 mm. Arizona..... .....**conicicollis** Csy.

Elytra similarly elongate, the body very elongate-oval, moderately convex, blackish-piceous in color, the legs pale rufous, the surface shining though just visibly alutaceous; head not finely or densely punctate, the punctures separated by nearly twice their own widths on the vertex; prothorax less narrowed anteriorly than in *conicicollis*, with a similar rather narrow and feeble basal lobe, about two-thirds wider than long, the apex but feebly sinuate and three-fourths as wide as the base, with the angles right and not prominent, the sides subevenly and moderately arcuate throughout, becoming subparallel basally, the basal angles right and evidently rounded, the punctures fine and sparse, becoming gradually rather coarse, dense, coalescent and forming long rugæ in only about lateral sixth; scutellum small, about an eighth as wide as an elytral base; elytra fully two-thirds longer than wide, about three times as long as the prothorax but not evidently wider, very gradually acutely ogival in fully posterior two-fifths, the sides very feebly arcuate, the series even, unimpressed and entire, composed of close-set punctures, very fine suturally, somewhat coarse, muricate and almost confluent, with the surface more opaque, laterally, the intervals excessively minutely, sparsely punctulate in very uneven single to double series; abdomen very minutely,

sparsely punctulate medially. Length 6.5 mm.; width 2.68 mm. Arizona (Riverside),—H. F. Wickham.....**libertus** n. sp.

Elytra oval, distinctly wider than the prothorax, where the basal lobe is strong and evenly rounded.....11

11'—Body elongate-oval, strongly convex, polished, dark castaneous, the under surface dark, the legs paler, rufous; head rather finely but perforately and not very closely punctate, the punctures close but not crowded, the epistoma arcuato-truncate, the sides strongly converging, evenly and only moderately arcuate; prothorax two-thirds wider than long, the evenly sinuate apex four-fifths as wide as the base, widest slightly behind the middle, the sides very evenly and rather strongly arcuate throughout, the basal angles right and not rounded, the punctures rather small but deep and separated by from two to three times their diameters, becoming obsolete along the basal lobe and rather abruptly coarse, confluent and forming longitudinal folds laterally, without median impunctate line, the surface broadly impressed toward the middle at base; scutellum small, transverse; elytra oval, gradually narrowed, with evenly arcuate sides, to the acutely ogival apex in apical half, less than one-half longer than wide and a fifth wider than the prothorax, the sides strongly arcuate, the humeri not exposed, the punctures fine, becoming coarse laterally, close-set in rather uneven and unimpressed series, the interstitial punctures fine, sparse, confused near the suture but frequently forming very uneven single series elsewhere; abdomen very minutely, sparsely punctate medially. Length 5.8 mm.; width 2.4 mm. Arizona (Winslow),—H. F. Wickham.....**discretus** Csy.

Body stouter, oval, convex, polished, dark rufous, the under surface and legs paler; head rather finely but very closely, substrigosely punctate, the sides moderately converging and strongly, evenly arcuate, the apical margin broadly and feebly arcuate: prothorax three-fifths wider than long, nearly as in *discretus*, except that the sides are parallel in basal two-fifths, becoming subsinuate toward base with the angles right and not rounded, moderately converging and straight toward apex, the punctures rather coarse, deep and close-set, becoming sparse or obsolete along the basal margin except at the sides, where they are rather abruptly coarse and longitudinally confluent; scutellum slightly larger, transverse; elytra as in *discretus* but more abruptly arcuately narrowed in only apical two-fifths to the more obtusely ogival tip, between two and three times as long as the prothorax and nearly a fifth wider, the sides strongly arcuate, the punctures stronger, coarse laterally, arranged in rather irregular unimpressed series, those of the intervals less sparse, more broadly confused and larger than in *discretus*, being about two-thirds as large as the serial punctures; abdomen rather finely but strongly, much more closely and conspicuously punctured medially than in *discretus*. Length 6.0 mm.; width 2.8 mm. Arizona (near Benson),—G. W. Dunn. **proprius** n. sp.

Body shorter, relatively stouter and more strongly narrowed before and behind than in *proprius*, strongly convex, polished, black or piceous-black, the legs blackish, paler distally; head finely, rather closely, substrigosely punctate, the epistoma densely and normally, the apex broadly arcuate, the sides strongly so, the angles obsolete; prothorax two-thirds wider than long, widest near basal fourth, where the sides are strongly rounded to the base, thence unusually converging to the greatly narrowed apex, becoming nearly straight, the apex deeply sinuate and only two-thirds as wide as the base, with the angles somewhat acute and prominent; punctures deep, not very fine and rather close-set, becoming rapidly coarse, dense, coalescent and forming long longitudinal rugæ in about lateral fifth; scutellum small, smooth; elytra strongly oval, rather more than one-half longer than wide, fully three times as long as the prothorax, and, at the middle, nearly a fourth wider, gradually becoming acutely ogival almost in apical half, the sides evenly and strongly arcuate to the base of the prothorax, the punctures coarse laterally, close-set in rather uneven unimpressed series, those of the intervals almost as large, confused suturally, in uneven single series laterally; abdomen finely, sparsely punctured medially. Length 5.8 mm.; width 2.82 mm. Texas (El Paso). — H. F. Wickham.

perovatus n. sp.

Body much narrower than in any of the preceding species, elongate-oval, convex, rather dull in lustre, blackish, the under surface rufescent, the legs bright rufous; head strongly but not very coarsely, closely and strigosely punctate, the converging sides strongly arcuate, the apex broadly and more feebly; prothorax short, more than three-fourths wider than long, widest just behind the middle, where the sides are moderately arcuate, thence becoming subparallel and very feebly so to the base and moderately converging and straight to the apex, the latter rather deeply sinuate and fully three-fourths as wide as the base, with the angles somewhat acute but not very prominent, the punctures rather coarse and very close-set, becoming abruptly dense but not much larger and forming long longitudinal rugæ in lateral sixth or seventh; there is a short and somewhat tumid medial impunctate line near the base; scutellum small; elytra fully three-fifths longer than wide, more than three times as long as the prothorax and nearly a fifth wider, gradually rather acutely ogival in about apical third, the sides evenly and moderately arcuate, the punctures rather large but shallow, moderately close-set in slightly irregular series, those of the intervals nearly as large, the sculpture rugulose, rendering the punctures indistinct; abdomen minutely, sparsely punctate medially. Length 5.1 mm.; width 2.23 mm. Arizona (Nogales), — H. F. Wickham. .....**aridus** n. sp.

The species more immediately allied to *convexus* Lec., form a difficult study and will require care in discrimination. The

sexual characters pertaining to the coriaceous last dorsal, or, perhaps more properly the penultimate dorsal, are varied and valuable in separating species otherwise distinguishable with difficulty, but unfortunately this segment is not often displayed to view. The species are all very local and the singular and isolated group of more or less opaque forms allied to *subopacus*, seems to be confined to southeastern Arizona. *Placidus* is the species from Mexico City, said by Mr. Champion to be identical with *pulvinatus*, from Oaxaca, but it does not agree with the description of that species and is undoubtedly different.

Stictodera n. gen.

This genus in the second group of the present tribe, possesses a form and facies not unremindful of *Cryptadius* of the first group, and this resemblance is strengthened by the non-serial elytral sculpture. The body is not quite so broadly oval but the prothorax has the same form, being strongly narrowed from base to apex, with obtusely rounded basal angles. In the form of the tibiæ it is quite apart from any other type of the tribe. The frontal emarginations are very minute and the epistoma is extremely feebly produced, with its apex not very broadly but rectilinearly truncate, the eyes large and rather prominent, with the superciliary carinæ fine, short and unusually feeble, and the mentum has a small and circularly rounded abrupt sinus at tip. The mandibles are thick but narrowed and deflexed toward tip and are feebly bifid; they are not properly toothed above, although the right mandible has an obtuse dorsal swelling. The metasternum is slightly shorter than the first ventral segment and the body is probably wingless. The single species known thus far may be described as follows: —

Body stout, oblong-oval, moderately convex, slightly alutaceous, red-brown, the under surface and legs paler and more rufous, glabrous; head not very coarsely but strongly, closely punctate, the sides before the eyes unusually short, not much longer than the eye, strongly converging, evenly and moderately arcuate; prothorax short and very transverse, evidently more than twice as wide as long, the deeply sinuate apex about three-fifths as wide as the base, which is transversely truncate and not medially lobed, widest near basal third, the sides rather strongly arcuate basally, becoming strongly converging and less arcuate apically, the punc-

tures rather coarse, deep and very close-set, not differing much laterally, though if anything rather smaller, in exception to the rule, and crowded though not very coalescent; scutellum rather small, transverse, rounded, flat; elytra two-fifths longer than wide, between three and four times as long as the prothorax but only just visibly wider, subparallel, the sides feebly arcuate, the apex gradually obtusely ogival, the punctures very fine, rather sparse, but little less fine laterally, arranged throughout without order, the usual series not even traceable; abdomen alutaceous, minutely, sparsely punctate, the metasternum coarsely, the propleuræ strigose. Length 7.0 mm.; width 3.2 mm. Lower California..... .... **pinguis** Lec.

The description is drawn from the female, in which sex the apex of the dorsum is feebly sinuate at the middle, with the surface at the middle of the sinus tumid and abruptly though minutely and angularly incised; there is also another smaller, medially and minutely sinuate coriaceous segment posterior to this.

Melanastus n. gen.

This genus is composed of small species somewhat resembling *Blapstinus*, generally black and more oblong than oval, inhabiting the usually arid regions from northern California to Nebraska and southward to northern Mexico. The head is moderate in size as in the preceding genera, rounded in front, never biemarginate: that is, never having the lateral lobes differentiated or at all prominent. The antennæ are shorter and stouter than in the preceding genera, though cylindrical to the eighth joint, and the eyes are less developed than in any other genus of the tribe, not prominent, but, on the contrary, rather flat in the majority of species, strongly transverse and at least half divided by the more or less prominent canthus of the frontal margin, the mentum large as usual, with a small apical sinus. The mandibles are not more deflexed apically and are unusually deeply and unequally bifid at tip, the left not toothed, the right with a small porrect dorsal tooth clasping the labrum. The prothorax is usually subparallel, but little narrowed at apex, more or less arcuate at the sides and with transversely truncate base, somewhat closely fitted to the elytra, the latter with the punctures more or less imperfectly serial, the scutellum small and the anterior tibiæ rather short but straight, increasing in

thickness from base to apex and unusually strongly spinulato-rugose. The metasternum is slightly shorter than the first ventral segment, the wings vestigial, the surface glabrous and the basal joint of the hind tarsi evidently longer than the last. *Melanastus* is evidently allied to *Mesabates*, of Champion, described in the "Biologia," but does not possess the trilobed front of that genus. Our rather numerous species, including one from Mexico, may be defined as follows: —

Eyes more distinct, coarsely faceted as usual, the prothorax finely but evidently margined at the sides.....2

Eyes smaller, somewhat more finely faceted than usual, the pronotum not margined at the sides.....21

2 — Elytral series never impressed, except very finely and obsoletely in a few species as mentioned below; prothorax seldom much narrower at apex than at base.....3

Elytral series distinctly and rather broadly impressed; prothorax subevenly and moderately narrowed from base to apex, — a very exceptional form in the present genus.....20

3 — Sides of the prothorax not distinctly sinuate before the obtuse basal angles.....4

Sides of the prothorax subparallel and arcuate, distinctly sinuate for a short distance at the basal angles, which are thereby rendered more or less prominent, subacute and never at all blunt.....14

4 — Elytra not distinctly wider than the prothorax, the sides of which are subparallel.....5

Elytra more or less evidently wider than the prothorax.....10

5 — Elytra shining.....6

Elytra dull, generally opaque.....7

6 — Form oblong-suboval, convex, shining, black, the under surface blackish, the legs dark rufous; head as wide as an elytron, rather coarsely but not densely punctate except at apex, where it is subrufescent, the surface very slightly alutaceous, the apex broadly arcuato-truncate; prothorax three-fourths wider to nearly twice as wide as long, the sides rather feebly arcuate, generally straighter toward apex and base, the basal angles only slightly obtuse and not at all blunt, the apex slightly narrower than the base, deeply sinuate, the punctures rather small but deep and sparse medially, becoming somewhat rapidly rather coarse, deep and close-set but scarcely confluent in lateral fourth; scutellum moderate, transverse, broadly rounded; elytra less than one-half longer than wide, three times as long as the prothorax or, in the female, a little more, acutely ogival at tip, the sides very feebly inflated and broadly

arcuate, the punctures moderate in size, very widely spaced in nearly even and wholly unimpressed series, the interstitial punctures but little smaller, arranged in irregular single series but broadly confused toward the suture; abdomen sparsely but rather strongly punctate medially. Length 4.8–5.3 mm.; width 1.85–2.2 mm. California (San Francisco).....**ater** Lec.

Form oblong-oval, slightly shorter than in *ater*, deep black, the legs dark rufo-piceous; head small, obviously narrower than an elytron, dull, very finely, rather sparsely punctate, the punctures coarser and close-set anteriorly, the sides strongly converging and strongly arcuate, the apex broadly arcuato-truncate; prothorax short, not quite twice as wide as long, the sides evenly and feebly arcuate, more converging anteriorly, the apex strongly sinuate, evidently narrower than the base, the punctures fine but deep, rather sparse, becoming closer and moderately coarse but still evidently separated in about lateral fifth; scutellum moderate, tumid; elytra two-fifths longer than wide, three times as long as the prothorax but scarcely perceptibly wider, the sides broadly, feebly arcuate, the apex gradually rather acutely ogival, the punctures somewhat coarse, close-set in subeven series, which are evidently though feebly impressed toward the suture, the interstitial punctures very fine, sparse, confused though sometimes forming uneven single series; abdomen smooth, minutely, sparsely punctate medially. Length 4.8 mm.; width 2.18 mm. California (near San Francisco),— G. W. Dunn.
mœstus n. sp.

Form nearly as in *ater* but less convex, still more highly polished, black, the legs piceo-rufous; head rather finely but deeply, very closely punctured, not quite as wide as an elytron, broadly, evenly arcuate at apex; prothorax about three-fourths wider than long, the apex narrower than the base and deeply sinuate, the sides parallel, evenly and very strongly arcuate, the basal angles very obtuse, the punctures not very coarse but perforate and rather close-set, becoming somewhat abruptly not much larger but still closer and partially confluent in lateral fourth; scutellum rather variable, moderate to minute in size; elytra three times as long as the prothorax to somewhat less, suboval, acutely ogival at tip in the male, obtusely in the female, the punctures rather coarse, not muricate, deeply impressed, not very close-set in somewhat uneven series, the interstitial punctures smaller but distinct in rather irregular single series even near the suture; abdomen sparsely but rather strongly punctate medially. Length 5.5 mm.; width 2.2–2.35 mm. Arizona (Seligman and Canyon Cosnino).
nitidus Csy.

7 — Color black, the elytral series not impressed..... 8

Color piceous-black to dark brown, the elytral series very narrowly and feebly impressed 9

8 — Body oblong-elongate, convex, slightly shining to alutaceous and sometimes duller; legs very dark rufous; head rather coarsely,

closely punctured, finely very densely so anteriorly, the sides convergent and evenly though moderately arcuate, joining the epistomal margin through a pronounced though rounded angle, the epistoma feebly and broadly lobed toward the middle; prothorax two-thirds wider than long, the sinuate apex narrower than the base, the sides subevenly and distinctly though moderately arcuate, the apical angles much deflexed, the basal very broadly obtuse but not rounded, the punctures rather small but deep, moderately separated, becoming slightly coarse and somewhat dense only very near the sides; scutellum moderate, transverse; elytra three-fifths longer than wide, not quite three times as long as the prothorax, gradually arcuato-ogival in apical two-fifths, the sides rounding toward base, the basal margin curving anteriorly toward the humeri, the punctures rather small but deep, moderately close-set in uneven series, the interstitial punctures fine, sparse and confused throughout; abdomen finely but strongly, somewhat sparsely punctate medially. Length 6.2–6.7 mm.; width 2.4–2.7 mm. California (middle coast regions)..... **obtusus** Lec.

9 — Form oblong, parallel, moderately convex, feebly shining, strongly alutaceous, dark brown in color, the legs dark rufous; head not very coarsely but deeply and very closely punctate, the sides converging and strongly, evenly arcuate, the angles not distinct, the epistoma broadly, feebly lobed, the tooth of the left mandible distinct, that of the right unusually large and acute; prothorax large, widest at the middle, three-fourths wider than long, the apex moderately sinuate and but little narrower than the base, the sides parallel, evenly and very strongly arcuate, the apical angles very strongly deflexed, the basal very obtuse, with the neighboring surface even, the punctures rather small but very deep and close-set throughout, nearly even and scarcely differing in any way toward the sides; scutellum rather well developed, transverse, sparsely and rather strongly punctate; elytra three-fifths longer than wide, fully three times as long as the prothorax but scarcely as wide as its median width, gradually and rather obtusely ogival apically, the sides rounding slightly basally, the basal margin only just visibly flexed anteriorly toward the humeri, the punctures not very coarse but deep, close-set and distinct in slightly uneven series, the interstitial punctures very fine, sparse and confused throughout; abdomen strongly, rather coarsely and closely punctured even medially. Length 6.6 mm.; width 2.45 mm. California (southern) ..... **thoracicus** Csy.

Form, coloration and lustre nearly similar; head similar and about as wide as an elytron, but with the third antennal joint less elongate and only very slightly longer than the fourth; prothorax larger, barely two-thirds wider than long, the subparallel sides very much less strongly arcuate and becoming straight toward base, the basal angles less obtuse and rendered apparently somewhat prominent by reason of an oblique tumidity of the surface extending to them, and not traceable in *thoracicus*, the anterior angles less deflexed and

much less obtuse, the punctures similarly strong, close-set and subequal throughout, not at all different toward the sides but becoming noticeably sparser toward the apical angles than elsewhere, a character not noticeable in *thoracicus;* scutellum much smaller; elytra nearly similar and similarly punctate but fully as wide as any part of the prothorax; abdomen feebly rugulose, shining, strongly and not sparsely punctate. Length 6.8 mm.; width 2.7 mm. California (probably southern).....**exoletus** n. sp.

Form nearly similar but smaller, feebly shining, the elytra opaque, piceous-black, the legs pale and bright rufous; head notably larger, slightly broader than an elytron, dull, the punctures rather small but perforate and very close-set, the sides converging and arcuate, the apex very broadly, feebly and subevenly arcuate throughout, the antennæ shorter and stouter than in either of the preceding species; prothorax scarcely more than one-half wider than long, the moderately sinuate apex evidently narrower than the base, the subparallel sides very moderately, subevenly arcuate, the apical angles rather deflexed, right, the basal very obtuse as in *thoracicus*, the adjoining surface even; punctures strong, perforate and close-set, becoming but slightly coarser and very close though scarcely coalescent laterally; scutellum moderate, transverse, impunctate except sparsely at base; elytra barely one-half longer than wide, less than three times as long as the prothorax and equal in width, the punctures of the irregular series much finer than in the two preceding, rather close-set, those of the intervals minute and sparse, in great part confused; abdomen very finely, sparsely punctate medially. Length 5.3 mm.; width 2.3 mm. California (San Bernardino Co.)..... ....**sterilis** n. sp.

10 — Basal margin of the elytra oblique and nearly straight from the scutellum to the humeral angles; sides of the prothorax parallel and subevenly arcuate throughout. Middle coast regions of California..... 11

Basal margin of the elytra strongly flexed anteriorly toward the humeri; prothorax more evidently narrowed apically in anterior half. Colorado and New Mexico. 12

11 — Body rather stout, strongly convex, polished throughout, deep black, the legs clear rufous; head somewhat coarsely, very deeply and closely punctate, equal in width to an elytron, very broadly arcuate throughout the apex, the sides converging and evenly, strongly arcuate; prothorax about two-thirds wider than long, the sides rather feebly arcuate, straight toward base, the angles obtuse, the apical angles rather deflexed, obtuse and blunt, the punctures fine but strong, rather sparse, becoming only slightly coarse and closer but still well separated laterally; scutellum small; elytra inflated behind the middle, scarcely one-half longer than wide and less than three times as long as the prothorax, but, behind the middle, at least a sixth wider, the sides broadly arcuate, the apex acutely ogival, the punctures moderately large, widely spaced in

subeven unimpressed series, those of the intervals very minute, sparse and feeble, generally uniserial laterally; abdomen smooth, polished, finely, sparsely punctate medially. Length 5.7 mm.; width 2.5 mm. California (San Francisco).....**lucidulus** n. sp.

Body nearly similar but less stout, duller and alutaceous in lustre, deep black, the legs piceous-black; head smaller, scarcely as wide as an elytron, nearly similar in form and sculpture; prothorax almost similar in form but less full before the middle, with the similarly moderately arcuate sides not becoming straight basally, the angles very obtuse, the anterior angles not so deflexed but obtuse, the apex similarly moderately sinuate and a little narrower than the base, the punctures similarly very fine but more close-set, becoming gradually rather coarse though scarcely closer toward the sides; scutellum small; elytra nearly similar in form and sculpture but subopaque, with the interstitial punctures more distinct and the series much more obsolete toward apex; abdomen alutaceous, very finely, sparsely punctate medially. Length 5.6 mm.; width 2.4 mm. California (Mt. Diablo)... **otiosus** n. sp.

12 — Color black, the legs clear but dark rufous, the body parallel. Rather stout, moderately convex, somewhat shining, the head not very coarsely but deeply and very closely punctured, broadly arcuate from side to side at apex, the sides only moderately converging, strongly arcuate, the third antennal joint fully twice as long as wide; prothorax but little more than one-half wider than long, the sinuate apex very distinctly narrower than the base, widest near the middle, the sides rather strongly and subevenly arcuate throughout but more converging apically, the basal angles very obtuse, the apical slightly obtuse and narrowly rounded, the punctures rather fine but deep, rather well separated but becoming gradually moderately large, close and somewhat longitudinally confluent laterally; scutellum well developed, transverse, narrowed toward base; elytra short, barely two-fifths longer than wide, two and one-half times as long as the prothorax and only slightly wider, perfectly parallel, with nearly straight sides rounding only very near the base, abruptly, obtusely rounded in barely apical third, the punctures small, rather close-set in extremely imperfect series, those of the intervals fine but distinct, confused laterally, almost as large as those of the broken series; abdomen polished, somewhat coarsely, not very sparsely, conspicuously punctate. Length 5.6 mm.; width 2.5 mm. Colorado (Canyon City).—H. F. Wickham..... **implicans** n. sp.

Color piceous or paler, the elytra generally paler than the anterior parts, the body oval..... 13

13 — Form rather stout, strongly convex, shining, castaneous, the under surface and legs paler and rufous; head somewhat coarsely, very deeply and closely punctate, broadly arcuate at apex, the sides only feebly converging and moderately arcuate, the third antennal joint fully twice as long as wide; prothorax about three-fifths

wider than long, the sides subevenly and rather strongly arcuate, more converging anteriorly, widest just behind the middle, the basal angles obtuse, the apical only moderately deflexed, right, only slightly blunt, the punctures rather small but deep, moderately separated, becoming rapidly larger, close and longitudinally subconfluent in about lateral fifth; scutellum as in *implicans;* elytra much more oval and more gradually and acutely ogival at tip, nearly one-half longer than wide, not quite three times as long as the prothorax, and, at the middle, obviously wider, the sides parallel and broadly, evenly arcuate, the punctures rather sparse, moderate in size and slightly larger laterally, confused throughout, the larger arranged in imperfect series becoming more distinct laterally; abdomen strongly, rather closely and conspicuously punctate throughout but especially toward the sides as usual. Length 6.2 mm.; width 2.75 mm. New Mexico (Santa Fé).

fallax Csy.

Form slightly less stout, otherwise nearly similar, shining, blackish-piceous, the elytra rufescent, the legs piceo-rufous; head nearly similar, about as wide as an elytron, the oblique sutures more distinct but not attaining the margin; prothorax nearly similar but rather shorter, the sculpture similar, except that the punctures do not become sparser toward the sides anteriorly as is the case in *fallax;* scutellum rather smaller, sometimes minute, the elytra nearly similar in general form but with the serial punctures extremely minute and still very small even toward the sides, the series imperfect, the interstitial punctures very minute, sparse and confused, equal to the serial punctures suturally but notably smaller laterally; abdomen finely, sparsely punctate medially, much less conspicuously so than in *fallax.* Length 5.6–5.8 mm.; width 2.32–2.5 mm. Colorado (Cab. Levette)...**finitimus** n. sp.

14 — Elytral series very obvious, distinct throughout the width of the elytra 15

Elytral series traceable with difficulty, especially toward the suture...17

15 — Elytra opaque. Body rather stout, oblong, parallel, rather strongly convex, deep black, the legs clear but dark rufous; head strongly, closely punctate, broadly and almost rectilinearly truncate at apex, the sides converging, broadly arcuate, the angles obvious though broadly rounded; antennæ even somewhat stouter than usual; prothorax subopaque, nearly three-fourths wider than long, moderately narrowed and rather feebly sinuate at apex, the sides broadly and somewhat feebly arcuate, more converging apically than toward base, the apical angles deflexed, right and blunt; punctures strong and close-set, becoming dense and somewhat larger laterally; scutellum small, tumid; elytra one-half longer than wide, scarcely three times as long as the prothorax and not evidently wider, the sides very feebly arcuate, the apex gradually and obtusely ogival, the punctures rather strong laterally, somewhat close-set in subeven unimpressed series, disappearing only

at apex, the interstitial punctures fine but strong, sparse, generally confused but forming irregular single series at some parts; abdomen slightly alutaceous, smooth, minutely and sparsely punctate medially. Length 6.0 mm.; width 2.5 mm. California (Humboldt Co.) ....**crassicornis** Csy.

Elytra more or less obviously shining..... 16

16 — Form rather stout, oblong-oval, strongly convex, very feebly alutaceous in lustre, deep black, the legs dark rufous; head rather coarsely, irregularly and somewhat closely punctate, the frontal margin very feebly and broadly angulate, the sides converging and arcuate, the angles feebly marked; antennæ rather less stout than in *crassicornis;* prothorax but little more than one-half wider than long, the sides subparallel, evenly and moderately arcuate, but little more converging anteriorly than posteriorly, the sinuation at apex strong, the apical angles right but narrowly rounded, the punctures not coarse but strong, well separated, becoming gradually a little larger and closer but not crowded, though tending to longitudinal coalescence, laterally; scutellum small, rounded behind; elytra slightly inflated, about two-fifths longer than wide, between two and three times as long as the prothorax and evidently, though slightly wider, the sides arcuate, rapidly rounding to the obtusely ogival apex, the series unimpressed, subeven, with not at all coarse, well separated but distinct punctures, the interstitial punctures very fine, confused suturally, sometimes forming uneven single series laterally; abdomen polished, smooth, strongly and not very sparsely punctate medially, coarsely and subrugosely so laterally. Length 6.0 mm.; width 2.45 mm. California (Amedee, Lassen Co.), — H. F. Wickham.....**æquicollis** n. sp.

Form narrower, elongate-oval, strongly convex, deep black, the legs dark rufo-piceous, polished; head not coarsely but very strongly and closely punctured, the sides converging and strongly arcuate, the apex broadly, very feebly angulato-arcuate, with the angles rather evident though obtusely rounded; prothorax two-thirds wider than long, the sides subevenly and rather strongly arcuate, slightly more converging anteriorly than posteriorly, the apex deeply sinuate, the apical angles right but scarcely at all blunt, the punctures not coarse but deeply perforate and moderately close-set, with a short impunctate discal median line, toward the sides only slightly larger or closer and still evidently separated; scutellum moderate, subquadrate, slightly transverse; elytra not quite one-half longer than wide, scarcely three times as long as the prothorax and not evidently wider, the sides broadly, evenly arcuate, gradually and obtusely ogival at apex, the serial punctures moderately coarse laterally, not very close-set, the series very feebly subimpressed suturally, the interstitial punctures very fine, unevenly uniserial throughout; abdomen finely, sparsely punctate medially, the elytral and abdominal punctures each with a very minute silvery seta. Length 5.25 mm.; width 2.25 mm. California (Truckee, Nevada Co.) .....**vegrandis** n. sp.

Form oblong-oval, rather stout, less convex, highly polished, deep black, the legs dark or subpiceo-rufous; head small, evidently narrower than an elytron, arcuate at apex with obsolete angles, rather coarsely, very closely punctate, rufescent at apex; prothorax very short and transverse, fully four-fifths wider than long, the sides subparallel, evenly and strongly arcuate to the abrupt basal sinus, the punctures fine but strong, well separated, becoming rather rapidly much larger and closer though not very coarse and still slightly separated in about lateral fourth; scutellum moderate, transverse; elytra inflated, about one-half longer than wide, fully three times as long as the prothorax and distinctly wider at the middle, the sides evenly and rather strongly arcuate, the apex obtusely ogival, the unimpressed, subeven series strongly and rather closely punctured, the intervals with uneven single series of punctures which are about half the size of the seriai punctures; abdomen not very finely, strongly and somewhat sparsely punctured medially. Length 4.8 mm.; width 2.12 mm. New Mexico (Fort Wingate) ..... **coarcticollis** Csy.

Form somewhat as in *coarcticollis* but more elongate and with much finer elytral punctures, deep black, the legs piceous-black, rather shining but not polished; head distinctly narrower than an elytron at the middle of its length, transversely suboval, the sides parallel, the angles very broadly rounded, the apex arcuate; punctures not very small, strong, rather well separated; prothorax not more than three-fifths wider than long, the sides subevenly and moderately arcuate, becoming deeply sinuate and then parallel and straight for a noticeable distance to the rectangular basal angles, the punctures fine and moderately sparse, becoming gradually moderately coarse, deep and slightly separated laterally; scutellum rather well developed, subtumid, transverse and punctate; elytra inflated, one-half longer than wide, barely three times as long as the prothorax and, at the middle, fully a fifth wider, gradually ogival in apical two-fifths, the sides evenly and very evidently arcuate to the rather acute and pronounced humeri, which are not exposed basally, the basal line curving rapidly forward laterally, the serial punctures very fine, not very close-set and but little less fine laterally, the intervals with extremely irregular single series of very minute punctures; abdomen polished, feebly rugose, finely but strongly, not closely punctured medially. Length 5.7 mm.; width 2.4 mm. Utah (Marysvale). — H. F. Wickham.

ludius n. sp.

17 — Elytra gradually narrowed and with feebly arcuate sides at apex, the tip very acute. Body elongate-oval, not very stout, convex, feebly alutaceous, deep black, the legs dark rufo-piceous; head not quite as wide as an elytron, strongly, very closely punctate, with a small elongate impunctate spot at the middle of the vertex, the apex strongly arcuate from side to side, the sides strongly arcuate with obsolete angles; prothorax two-thirds wider than long, the sides subevenly and rather strongly arcuate, somewhat

more converging apically, widest behind the middle, the sinuate apex distinctly narrower than the base, the punctures relatively large, very deep and close-set, somewhat uneven, becoming gradually rather coarse and very close laterally; scutellum small, quadrate; elytra fully one-half longer than wide, three times as long as the prothorax but only just visibly wider, the sides very feebly arcuate, the punctures fine, rather sparse, confused though with some feebly defined and subeven series toward the sides; abdomen highly polished, rather sparsely but not very finely, strongly punctured medially. Length 5.2 mm.; width 2.28 mm. Colorado. **acuminatus** n. sp.

Elytra more rapidly, arcuately narrowed and obtusely ogival at tip..18

18 — Antennæ very short, the seventh and eighth joints wider than long. Body very small, oblong-oval, moderately convex, rather stout and shining, deep black, the legs piceo-rufous; head small, not as wide as an elytron, rather finely but strongly, closely punctate, broadly arcuate at apex, the sides almost parallel, the angles broadly rounded but evident; prothorax about three-fifths wider than long, widest just behind the middle, the sides distinctly arcuate, more feebly so and feebly converging before the widest section, more abruptly rounded posteriorly to the ante-angular sinus, the apex rather feebly sinuate, but little narrower than the base, the punctures strong, separated by nearly twice their diameters, gradually but little larger and irregular but very close-set in part laterally; scutellum moderate, transverse; elytra inflated, two-fifths longer than wide, barely three times as long as the prothorax, and, at the middle, nearly a fifth wider, the sides parallel and distinctly arcuate, the punctures fine and sparse but rather deep, confused though with some feebly defined series basally and laterally; abdomen finely, sparsely punctured medially. Length 4.3 mm.; width 1.95 mm. Colorado (Garland)...**parvus** n. sp.

Antennæ less abbreviated, the eighth joint fully as long as wide as usual 19

19 — Form rather stout, oblong, parallel, rather strongly shining, deep black, the legs piceo-rufous; head small, very evidently narrower than an elytron, nearly as in *parvus* but more acicularly punctured; prothorax relatively larger, three-fifths wider than long, widest near the middle, nearly as in *parvus*, the punctures rather finer and closer but similarly deep and perforate, becoming gradually but little larger though very close-set and even laterally and with a rounded median impression at base; scutellum small, transverse; elytra less oval, not inflated, two-fifths longer than wide, scarcely more than two and one-half times as long as the prothorax and not evidently wider, the sides parallel and feebly arcuate, the punctures minute, rather sparse, confused though with feeble evidences of irregular series basally and laterally; abdomen smooth, polished, slightly rufescent, not very finely but sparsely punctate. Length 4.7 mm.; width 2.17 mm. Nebraska. **acutus** Horn

Form less stout, strongly convex, slightly alutaceous, deep black, the legs rufo-piceous; head as wide as an elytron and more transverse but otherwise similar, the punctures less aciculate, strong, perforate and close-set; prothorax relatively smaller, but little more than one-half wider than long, otherwise similar and rather feebly sinuate at tip but with the punctures a little larger and less close-set, although similarly crowded laterally and with the base not quite as wide as the base of the elytra, the humeral angles being slightly exposed at base; scutellum moderate, transverse; elytra narrower and more elongate in the female, the only sex at hand, with the sides much less arcuate, nearly one-half longer than wide, scarcely three times as long as the prothorax and very little wider, the punctures somewhat sparser but rather stronger and, although generally confused, more distinctly seriate at various parts of the surface than in *acutus;* abdomen minutely, sparsely punctate medially. Length 5.0 mm.; width 2.15 mm. Colorado (Cab. Levette.).....**exiguus** n. sp.

20 — Form oblong-oval, strongly convex, polished, the elytra feebly alutaceous, black, the anterior parts and under surface occasionally and sometimes the elytra, also, though less strongly, rufescent, the legs dark rufous or paler; head moderately coarsely and very closely punctate, the frontal margin broadly, rectilinearly truncate, the sides converging but strongly arcuate, becoming parallel toward the eyes, the angles obliterated; prothorax two-thirds to three-fourths wider than long, the sides moderately converging, subevenly and moderately to feebly arcuate from base to apex, the latter only very feebly sinuate, the punctures deep and rather coarse, more or less evidently separated, becoming abruptly dense, though not much larger, and longitudinally anastomosing in lateral sixth or seventh; scutellum moderate, transverse, projecting behind the basal margin; elytra short, two-fifths longer than wide, scarcely two and one-half times as long as the prothorax and somewhat wider, the sides rounding toward base, the apex rather acutely ogival, the punctures of the broadly impressed and almost regular series moderately coarse, close-set, those of the intervals very minute, confused; abdomen smooth, polished, finely but strongly, sparsely punctured medially. Length 4.4–5.3 mm.; width 1.8–2.25 mm. California (San Diego). [= *nanulus* Csy.].....**obesus** Lec.

21 — Body oblong, stout, moderately convex, rather shining, deep black, the legs black with slightly piceous tinge; head somewhat coarsely, deeply, densely punctate, the punctures longitudinally confluent laterally, smaller but not crowded on the epistoma, the anterior margin strongly and almost uniformly arcuate from one eye to the other; antennæ black, slightly paler distally; prothorax transverse, fully four-fifths wider than long, the sides subevenly and strongly arcuate, sometimes more arcuate near the base, the apex deeply sinuate, about three-fourths as wide as the base, with the angles slightly obtuse and very blunt, the basal angles very

obtuse, the punctures small, elongate, very close-set, becoming gradually not larger or transversely closer but longitudinally anastomosing laterally; scutellum moderate, transverse; elytra evidently less than one-half longer than wide, three times as long as the prothorax to materially less and equal in width, the sides very feebly arcuate, the apex somewhat acutely ogival, the punctures rather small but deep and distinct, not very close-set and uniform in size throughout, generally confused but with ill-defined and incomplete series traceable here and there; abdomen with rather small but deep, moderately sparse, conspicuous punctures medially. Length 4.8–5.7 mm.; width 2.0–2.5 mm. Mexico (Chihuahua — near Colonia Garcia, 7,300 feet elevation),— C. H. T. Townsend.

* **sonoricus** n. sp.

Body nearly as in *sonoricus* but rather less stout and with the elytra much more evidently seriate, black or piceous-black, the legs and antennæ obscure rufous, moderately shining; head moderate, the sides feebly converging and slightly arcuate, the apex arcuate, the punctures rather fine but deep, elongate and longitudinally subcoalescent; prothorax variable, from a little less to obviously more than twice as wide as long, the sides subparallel and strongly, evenly arcuate, sometimes more converging anteriorly from behind the middle — probably in the male, — the hind angles very obtuse but not blunt or prominent, the punctures fine, perforate, very close, becoming but little less fine though longitudinally confluent gradually toward the sides; scutellum variable; elytra scarcely one-half longer than wide, three times as long as the prothorax to obviously less and not at all wider, ogival behind, the sides feebly arcuate, the basal line curving forward moderately toward the humeri, the punctures rather small but deep and conspicuous, only moderately close-set in subeven, unimpressed series, scarcely visibly larger laterally, the intervals with sparse, confused punctures, but little smaller than those of the series, rendering the latter less obvious; abdomen finely but strongly, sparsely punctate. Length 5.2–5.4 mm.; width 2.2–2.3 mm. Arizona (Fort Apache) ..... **nuperus** n. sp.

As remarked by Mr. Champion of *Mesabates*, many of the species of *Melanastus* greatly resemble *Blapstinus* in general facies, being more elongate, narrower and less convex than in *Steriphanus*. The species appear to be satisfactorily differentiated, but the series of specimens representing *sonoricus* and *nuperus* in my cabinet are rather puzzling; the description relates to normal and fully formed individuals but, in several of the former species, the punctures toward the sides of the prothorax are notably less crowded: in one specimen of each species the prothorax is widest near the base: in another, of *sonoricus*, the

elytra become rugose, an accidental variation often seen in *Coniontis* and some other Tenebrionids.

Tribe Auchmobiini.

This is the only tribe, the propriety or legitimacy of which is at all doubtful to me. The single species, *Auchmobius sublævis*, was described many years ago by LeConte (Ann. Lyc. N. Y., 1851), in few words and has been alluded to twice since that time by Horn. The following descriptions are based wholly upon these published observations. There is but one described genus as follows: —

Clypeus produced anteriorly, oblique at the sides, the apex deeply emarginate, covering the labrum [LeConte]; labrum moderately prominent, feebly emarginate [Horn]; eyes feebly emarginate, transverse, without supra-orbital carina; mentum large, flat, subpentagonal, the apex emarginate; palpi and antennæ wanting in the type specimen [LeConte]; maxillary palpi slender, with the last joint broader; antennæ with the first three joints nearly equal and longer than the others, four to ten gradually increasing in width, compressed, wider than long and trapezoidal, the last joint oval, acute and smaller than the preceding [Horn]; anterior tibiæ not at all dilated, the apex truncate [LeConte], with the outer angle prolonged, the tarsi with spinous hairs beneath [Horn]; mandibles obtuse, feebly grooved above, not clasping the middle lobe of the epistoma, allowing the labrum to be partly visible while they are completely invisible from above when folded [Horn]; posterior coxæ approximate. Body somewhat elongate, convex, slightly dilated posteriorly [LeConte], very robust, broadly oval, very convex [Horn]; prothorax and elytra closely joined, the facies somewhat that of *Eurymetopon*..... .....**Auchmobius**

If the antennæ are properly described above, the necessity for tribal separation of *Auchmobius* becomes quite evident.

Auchmobius Lec.

The single described species is the following, the diagnosis being that of LeConte (Ann. Lyc. V, p. 140): —

Oblong, somewhat elongate, convex, black, rather shining; prothorax finely punctulate, more than twice as wide as long, the base truncate, the sides slightly rounded; elytra finely punctate [rather coarsely — Horn], behind the base somewhat broader, narrowed toward apex, strongly declivous and finely, less densely muricate. Length 10.0 mm. California (Vallecito) [LeConte]; Owens Valley and Tejon [Horn].....**sublævis** Lec.

There can be but little doubt that two or three species have been confounded by the two authors, but it is less likely that there can be more than the one genus, although the discrepancies in the tibial characters, as noted above, seem to be rather pronounced. It may be noted that *sublævis* is larger than any known species of the tribe Eurymetoponini, excepting the Mexican genus *Posides*, of Champion.

Tribe Trimytini.

The genera of this tribe differ among themselves in very much the same way and to nearly the same extent as those of the Eurymetoponini, excepting one element of minor importance relating to the basally narrowed prothorax of *Chilometopon*, which is foreign, so far as known, to that tribe. In geographic range the two tribes coincide closely, except that the Trimytini do not seem to invade the true Pacific coast faunal region, and they also possess a similar corporeal habitus. Our genera may be readily separated by the following characters: —

Outer ridge of the mandibles very broad, not definitely dentiform at base..... 2

Outer ridge very narrow, with a small dentiform protuberance at base..... 3

2 — Body short, glabrous, convex, wingless, the metasternum somewhat shorter than the first ventral segment and with the usual transverse grooves represented only by an unimpressed line of smaller punctures; eyes moderately large and not prominent, generally about two-thirds divided by the canthus of the frontal margin; prothorax usually widest at base. [Type *T. pruinosa* Lec.].....**Trimytis**

Body elongate, convex, glabrous, winged, the metasternum very much longer than the first ventral and with very deep and subentire antecoxal transverse grooves; eyes large, slightly prominent and only very slightly emarginate anteriorly; tarsi long, the basal joint of the posterior longer than the last two combined; prothorax widest at about the middle, the apex and base subequal; last antennal joint normal, about as long as the tenth. [Type *P. amplipenne* n. sp.].....**Prometopion**

3 — Body as in *Prometopion* but smaller and narrower, convex, glabrous, fully winged, the metasternum and transverse grooves similar, the eyes similarly large, prominent and only very feebly emarginate anteriorly; tarsi long, the basal joint of the posterior variable; prothorax always narrowed toward base and widest

before the middle; last antennal joint elongate, sometimes extremely so. [Type *Trimytis abnormis* Horn].....**Chilometopon**

All of these genera have the eyes very coarsely faceted, the epistoma greatly prolonged, subquadrate and clasped by the external ridge of the mandibles, the latter bifid at tip, the maxillary palpi well developed, with the last joint wider, elongate and obliquely truncate, the antennæ elongate and filiform, with the last three or four joints wider, the scutellum well developed, the elytra punctured in series, the tibiæ straight, the anterior with uneverted external angles and the tarsi sparsely clothed beneath with stiff inclined spiniform hairs. One or possibly two of the genera described by Mr. Champion in the "Biologia," will enter this tribe, notably *Pescennius*, which Horn regards merely as a hairy *Trimytis;* it is however a widely distinct genus.

Trimytis Lec.

The species of this genus are rather short and compact in build, very convex, reminding us somewhat of *Steriphanus*, of the Eurymetoponini, and, as in that genus, the base of the prothorax may be either lobed or transversely rectilinear. The elytra are always margined at base, the scutellum transverse, broadly truncate and not projecting posteriorly behind the raised margin, differing in this way from the other two genera. *Trimytis* may be separated into two very distinct groups, which may be regarded at present as subgenera, as follows: —

Mandibles short, obtuse, not at all dentate above near or beyond the middle, folding under the labrum and clasping only the epistomal lobe, which is abruptly and squarely truncate at tip; prothorax transversely subrectilinear at base; tarsi rather short, the basal joint of the posterior distinctly longer than the fourth. [*Trimytis* in sp.].....2

Mandibles stout, with the apex abruptly narrowed and deflexed, each with a porrect dorsal tooth, moderate on the left, strong on the right, both clasping the labrum and lying against the epistoma when closed, the latter semicircular in form, with its edge finely pectinate in *pulverea*, angulate in *obtusa;* prothorax of the same general form but distinctly lobed at base; tarsi short, the basal joint of the posterior subequal to the fourth. [*Pimalius* n. subg. —type *pulverea* Horn].....6

2 — Epistoma minutely and sparsely punctate. Body very stout, highly polished, deep black, the under surface piceseent, the legs

dark piceo-rufous; head transverse, the occiput rather finely punctato-strigose but only near the base at the middle, more completely and obliquely rugulose toward the eyes, the vertex very minutely, sparsely punctulate and polished; prothorax nearly three-fourths wider than long, the apex evidently narrower than the base, both subtruncate, the former however with the angles acute and anteriorly prominent, the basal angles slightly acute and distinctly, posteriorly produced, the sides feebly and subevenly arcuate; disk widest at base, the punctures uneven, large and small intermingled, generally moderate in size and very sparse medially, without impunctate line, gradually very coarse and close laterally, becoming confluent only very near the sides; elytra scarcely two and one-half times as long as the prothorax, and, behind the middle, slightly wider, the sides slightly arcuate, the apex very obtusely subparabolic, the punctures very coarse, close-set in slightly impressed series, becoming obsolescent at apical third, the intervals subconvex, finely, sparsely and confusedly punctate; abdomen finely, sparsely punctate medially. Length 6.0 mm.; width 3.0 mm. Texas (Marfa).....**nympha** n. sp.

Epistoma finely but more strongly and densely punctate.....3

3 — Apical angles of the prothorax very broadly produced anteriorly; elytral punctures very coarse, the series somewhat impressed.....4

Apical angles very abruptly produced anteriorly; elytral punctures much smaller, the series unimpressed, the intervals flat..... 5

4 — Form rather elongate, strongly convex as usual, black, the under surface and legs dark-rufous, polished; head nearly as in *nympha* but with the punctured strigæ stronger and more wide-spread, the vertex finely, sparsely punctate at the middle anteriorly; prothorax two-thirds wider than long, widest at the base, the apex much narrower, truncate except toward the advanced acute angles, the basal angles right and evidently produced posteriorly; sides subevenly and moderately arcuate, becoming a little more converging and slightly sinuate near the apex, the surface subevenly but rather coarsely, moderately closely punctate, without impunctate line, the punctures rapidly still coarser, dense and longitudinally confluent in about lateral sixth; elytra two and three-fourths times as long as the prothorax, and, at the middle, slightly wider, the sides broadly arcuate, the apex somewhat gradually but obtusely ogival, the very coarse and moderately close-set serial punctures becoming obsolescent at apical two-fifths; abdomen finely, sparsely punctured medially, the basal segment coarsely so throughout. Length 5.5–6.7 mm.; width 2.65–3.0 mm. Colorado and New Mexico..... .....**pruinosa** Lec.

Form much stouter and decidedly piceous in color, the elytra frequently dull rufous, the under surface and legs paler rufous, shining; head similarly rather coarsely punctato-strigose; prothorax three-fourths wider than long, the apex and base as in *pruinosa* but with the basal angles much less distinctly produced posteriorly, the sides

parallel and nearly straight from the base to beyond the middle, where they are broadly rounded, thence converging and feebly sinuate to the prominent apical angles as in *pruinosa*, the punctuation still coarser, moderately close and more uneven, with fewer coarse punctures intermingled, without impunctate line, becoming abruptly not much coarser but very dense and confluent only in about lateral eighth of the width; elytra nearly as in *pruinosa* but less elongate, with the interstitial punctures small, sparse and similarly confused, the serial punctures very coarse, except in apical two-fifths; abdomen feebly rugulose, finely but more strongly, sparsely punctured medially, the basal segment very coarsely so throughout. Length 5.2–6.1 mm.; width 2.4–3.0 mm. Colorado..... **tonsa** n. sp.

5 — Body rather broadly oval, moderately convex, shining, piceous, the elytra and under surface rufescent, the legs dark piceo-rufous; head nearly as in *pruinosa* but less strigose, especially toward the middle of the occiput; prothorax fully two-thirds wider than long, the sides feebly arcuate, becoming parallel from behind the middle to the base, converging and becoming subsinuate to the very acute apical angles, the basal angles right, slightly prominent posteriorly, the apex much narrower than the base, the latter very feebly sinuate toward the sides; punctures rather large, very deep, even in size and distribution and separated by about twice their own diameters, with a narrow and distinct median impunctate line, very gradually becoming only slightly larger but dense though not perfectly coalescent laterally; elytra in form nearly as in *tonsa* but with the punctures of the unimpressed series only moderately coarse and well separated, becoming subobsolete in apical two-fifths; abdomen feebly rugulose, finely, sparsely punctate medially, the basal segment throughout sparsely and not very coarsely punctate. Length 5.0 mm.; width 2.3 mm. Colorado...**ignava** n. sp.

6 — Form oblong-oval, strongly convex, strongly alutaceous in lustre, piceous-black, the legs rufous; head but little wider than long, somewhat coarsely, extremely densely punctato-strigose throughout, except in a very small triangular spot just behind the epistoma, which is simply punctate; prothorax transverse, nearly four-fifths wider than long, the apex but little narrower than the base and evenly, moderately sinuate from angle to angle, the latter only slightly acute and not prominent, the base broadly lobed in the middle, thence transverse and subrectilinear to the angles, which are slightly obtuse, the sides feebly arcuate; disk slightly wider at basal third than at base, very coarsely, deeply and closely punctured throughout, the punctures becoming longitudinally confluent laterally but scarcely at all larger, without suspicion of a median impunctate line; elytra scarcely a third longer than wide, two and one-half times as long as the prothorax and scarcely visibly wider, with feebly impressed series of coarse, deep and not very close-set punctures, extending to the apex and not abbreviated as in the preceding species, the intervals very minutely,

sparsely and confusedly punctulate; abdomen rather coarsely and closely punctured throughout, the metasternum extremely coarsely. Length 5.0 mm.; width 2.3 mm. Arizona .....**pulverea** Horn

Form oblong, piceous-black, moderately shining, the antennæ pale, the legs brownish; head densely and somewhat strigosely punctate, the epistomal lobe obtusely triangular; prothorax at the middle about twice as wide as long, the sides regularly arcuate, the base and apex nearly equal, with the angles obtuse; disk moderately coarsely and closely punctate, somewhat strigose at the sides; elytra at base slightly wider than the prothorax, with striæ of fine punctures not closely placed, the intervals irregularly, biseriately punctate, the punctures of the striæ and intervals confused behind the scutellum; sterna very coarsely punctured, the propleuræ strigose; abdomen moderately coarsely, not closely punctured. Length 4.0–4.5 mm. Lower California (Sierra Laguna).....**obtusa** Horn

Although Dr. Horn has not described the mandibles or the form of the prothoracic base in *obtusa*, which is unknown to me, I believe, from the general nature of its characters, that it is to be associated with *pulverea* in the subgenus *Pimalius*. The very radical difference in the mandibles seems to indicate that *Pimalius* really ought to have generic rank, but because of its general resemblance to the normal *Trimytis*, I leave it with the indicated status for the present. Of the two Mexican species described by Mr. Champion in the "Biologia," *obovata*, from Chihuahua, is evidently an associate of *pruinosa* and a normal member of *Trimytis*, but *flohri*, from the vicinity of the City of Mexico, because of its prominent and scarcely emarginate eyes, must inevitably form another genus, for which I would propose the name **Tlascalinus** (n. gen.); it may take its place immediately after *Trimytis* in the above table.

Prometopion n. gen.

This genus in its general form and habitus, constitutes a satisfactory transition from *Trimytis* to *Chilometopon*. The hind wings appear to be rather well developed, but, from the heavier form of the body, the flight is probably more laborious than in the lighter and more slender *Chilometopon*. The mandibles are thick and heavy, with a broad smooth external ridge above, clasping the epistoma as in *Trimytis*, but the apex is broad and very obtuse, feebly bifid, the upper lobe very wide

and transversely truncate, the lower small and more pointed. The epistomal lobe is squarely truncate, with converging sides. The eyes are large, prominent, subentire and coarsely faceted, with the supra-orbital carina much finer and feebler than usual, the prothorax narrower than the elytra, the latter having the humeri exposed at base, and the basal joint of the hind tarsi is unusually elongate, being four-fifths as long as the entire remainder. The legs are rather long and slender. The two species known thus far may be outlined as follows: —

Form oblong-oval, shining, castaneous; head broadly oval, the mandibles and clypeus coarsely and densely punctured, the vertex and occiput much more sparsely; prothorax nearly twice as wide as long, the apex feebly emarginate, the anterior angles acute and very slightly everted, the base broadly rounded at the middle, feebly sinuate at each side, the hind angles subacute but not prominent, the sides moderately arcuate and slightly divergent to base; elytra slightly broader at base than the prothorax, elongate-oval, the sides moderately arcuate, the humeri distinct, the surface moderately convex, sparsely punctured, the punctures feebly seriately arranged, becoming slightly muricate and dense at the sides and apex; epipleuræ entire; mesosternum coarsely and densely punctured; metasternum moderately long at middle, very sparsely punctured, the sides and parapleuræ very densely; abdomen sparsely punctured, the femora coarsely but sparsely. Length 6.5 mm. California..... ....**helopioides** Horn

Form elongate-oval, strongly convex and shining, black or piceous-black, the under surface and legs more or less dark piceo-rufous; head rounded, nearly as long as wide, not coarsely but strongly, moderately closely and evenly punctate, the punctures somewhat elongate, finer but scarcely sparser on the occiput; antennæ nearly two-fifths as long as the body; prothorax three-fourths wider than long, the apex and base equal in width, the former evenly sinuate between the finely acute and anteriorly prominent angles, the latter lobed in the middle and thence feebly sinuate to the angles, which are obtuse but not at all rounded, the sides broadly and moderately arcuate at the middle, converging and straighter toward base and apex, not sinuate behind the apical angles which are not everted; disk widest at the middle, with rather small and sparse punctures, becoming somewhat rapidly coarse and very dense but scarcely at all confluent in lateral fifth or less, the surface feebly impressed before the basal lobe and with a fine and very short impressed longitudinal line near the basal margin; scutellum well developed, flat, nearly as long as wide, evenly and circularly rounded behind and projecting behind the basal margin; elytra elongate-oval, between three and four times as long as the prothorax, and, somewhat behind the middle, fully a third wider, the sides broadly

arcuate, the apex rather gradually ogival, the punctures somewhat fine, sparse, uniform in size, for the most part confused but with poorly defined series evident under close examination; metasternum and parapleuræ throughout only moderately coarsely, though strongly and sparsely punctate, the abdomen minutely and sparsely so, only slightly less finely toward the sides. Length 7.0–7.7 mm.; width 3.2–3.35 mm. Texas (near El Paso).

amplipenne n. sp.

The description of *helopioides* is taken from the original diagnosis of Horn, and there seems to be but little room to doubt the specific distinctness of *amplipenne*, in view of the differences in the form of the anterior angles of the prothorax, punctuation of the head and sterna, coloration and habitat.

Chilometopon Horn.

In this genus, which is characterized by a smaller and slighter form of body, the mandibles differ greatly from those of *Prometopion*, being less stout, with a fine external dorsal ridge dentiformly swollen at base and similarly clasping the epistomal lobe, which has the sides more converging and the apex more rounded. The apex of the mandibles is much narrower and is deeply bifid, the two lobes differing but little in size and both acutely pointed. It further differs in the form of the prothorax and in the elongate terminal joint of the antennæ. The scutellum is similar though more subquadrate, rounded behind and entering sensibly between the elytra. The eyes are similarly large, prominent and very feebly emarginate, and the supra-orbital carina is fine but distinct; the tarsal claws are similarly long and arcuate. We have apparently five species, which may be distinguished as follows: —

Basal joint of the hind tarsi very elongate, equal to the last two combined; epistomal lobe rounded 2

Basal joint but little longer than the fourth, the epistomal lobe abruptly arcuato-truncate 4

2 — Head rather coarsely and densely punctured. Body chestnut-brown in color, subopaque, last antennal joint as long as the two preceding together; prothorax broader than long, narrower at base than at apex and narrower than the base of the elytra, the disk moderately convex, coarsely and moderately densely punctured, especially toward the margins, the apex feebly emarginate, the base slightly sinuate [bisinuate], the sides rounded in front,

gradually narrowed [converging] to the hind angles, which are rectangular; elytra elongate-oval, subparallel in front, moderately convex, with striæ of finely muricate punctures, confused at base and less distinct at apex; under surface coarsely but not densely punctured, the abdomen paler, more shining and scarcely at all punctured. Length 6.5 mm. Nevada.....**abnorme** Horn

Head rather finely and not densely punctured.....3

3 — Form elongate, moderately convex, shining, pale and uniform castaneous in color throughout; head as long as wide, very convex anteriorly, the epistoma sloping anteriorly from the elevation, the punctures small, well separated, elongate in form and streaming obliquely outward from the median line anteriorly, forming fine longitudinal folds toward the strong supra-orbital carinæ; last antennal joint (♀) scarcely as long as the two preceding combined; prothorax small, nearly three-fourths wider than long, widest at apical third, where the sides are strongly rounded, thence converging and straight to the basal angles, which are obtuse but not at all rounded, converging and arcuate to the acute and anteriorly prominent apical angles, the apex broadly, evenly sinuate, equal in width to the base, which is strongly and rather narrowly lobed in the middle; punctures very slightly elongate, sparse and moderately small, becoming gradually close-set and coarse but scarcely confluent laterally, with an incomplete impunctate median line; scutellum as long as wide, ogival at tip, narrowed somewhat at base; elytra nearly three-fourths longer than wide, four times as long as the prothorax, and, at the middle, one-half wider, the sides broadly arcuate, the apex gradually acutely ogival, the humeri broadly exposed at base, rounded, the punctures fine, sparse, shallow, scarcely muricate, subequal in size, confused toward the suture, forming approximate series outwardly continuous from base to apex; metasternum sparsely, moderately coarsely and muricately punctate, the abdomen not evidently punctate medially. Length 6.4 mm.; width 2.38 mm. California (Barstow).....**castaneum** n. sp.

Form shorter and stouter, convex, somewhat alutaceous, dark piceo-rufous, the elytra blackish, the legs paler rufous; head slightly wider than long, nearly as in *castaneum* but feebly impressed along the median line and without the pronounced convexity involving the apex of the front and base of the epistoma, the last antennal joint in the type but little more than one-half longer than the tenth; prothorax nearly similar but less transverse and more broadly rounded at the sides, about one-half wider than long, the apex more feebly sinuate, with the angles less anteriorly produced and the basal lobe broader, the punctures nearly similar but less sparse medially and without a median impunctate line, the latter however apparently very feebly elevated behind the middle and with a fine stria near the base; scutellum subsimilar; elytra much shorter, distinctly inflated behind the middle, one-half

longer than wide, three and one-half times as long as the prothorax, and, at apical two-fifths, about one-half wider, the sides broadly arcuate, the apex more rapidly and obtusely ogival, the humeri and punctuation similar, the punctures fine and very shallow; metasternum similar, polished, the abdomen subopaque, minutely, sparsely punctate medially. Length 5.4 mm.; width 2.4 mm. Utah (Leeds).— H. F. Wickham.....**brevipenne** n. sp.

Form much more slender, rather pale and uniform testaceous throughout, shining; head nearly as in *brevipenne* but as long as wide, finely, very sparsely punctured medially and without the impressed line, the antennæ (♂) more than half as long as the body, with the last joint ensiform and as long as the preceding five joints combined; prothorax small, nearly three-fourths wider than long, formed nearly as in *brevipenne* but with the apex perceptibly wider than the base, similarly broadly sinuate but with the angles decidedly blunt and not acute, the basal angles obtuse but minutely prominent, the sculpture almost as in *castaneum* though rather coarser and with a more irregular impunctate median line; scutellum similar; elytra nearly as in *castaneum*, much narrower and more acute at tip than in *brevipenne*, four times as long as the prothorax, and, at the middle, one-half wider, the sides parallel and evenly arcuate, the humeri broadly rounded, widely exposed at base, the punctures fine, shallow but unusually muricate, close-set in entire series, the intervals irregularly uni- or biseriately and subsimilarly-punctate as usual; the surface becomes more polished and the serial punctures coarser on the vertical flanks toward base. Length 5.0 mm.; width 2.0 mm. Nevada (Hawthorne), —H. F. Wickham.....**ensifer** n. sp.

4 — Body rather stout, convex, shining, pale yellowish-testaceous throughout; head about as long as wide, rather coarsely, sparsely and simply punctate posteriorly, the punctures smaller, dense and obliquely strigose anteriorly, small, separated and simple on the epistoma, the supra-ocular carinæ strong; mentum minutely, sparsely punctate; antennæ long and slender, the last joint as long as the two preceding combined and bristling with short erect setæ (♂), or much shorter and only about a third longer than the tenth (♀); prothorax nearly two-thirds wider than long, widest at apical two-fifths, where the sides are narrowly and subprominently rounded, thence converging and straight to the rectangular and slightly everted basal angles, less converging and straight to the acute and anteriorly prominent apical angles, the apex broadly subtruncate between the advanced angles and about as wide as the base, which is broadly lobed at the middle, the punctures rather coarse, sparsely scattered rather narrowly along the middle, thence gradually denser and coarser but not confluent to the sides; scutellum fully as long as wide, acutely rounded, constricted at base; elytra nearly as in *castaneum*, much broader and relatively shorter in the female than in the male, the punctures rather small, shallow, feebly muricate, close-set in subentire and unimpressed series, the inter-

vals with a single uneven series of rather smaller, more widely spaced punctures; abdomen finely but distinctly, not very sparsely punctured medially. Length 6.3–7.0 mm.; width 2.4–2.85 mm. Texas (near El Paso)..... .....pallidum Csy.

As tending to show the propriety of associating the genera from *Trimytis* to *Chilometopon*, to form a natural tribe, it may be noted that the anterior angles of the prothorax bear vibrissæ, particularly long and conspicuous in *Chilometopon* and *Prometopion*, but shorter and less evident in *Trimytis*, though so distinct in *Trimytis obovata* as to have been especially mentioned by Mr. Champion, and, as further tending to show the intimate relationship of the Trimytini and Eurymetoponini, attention may be drawn not only to the similarity of general habitus, but to the singular short longitudinal impression on the lower part of the elytral flanks before the middle, so prevalent in both tribes, becoming obsolete only in *Trimytis* and a few subapterous Eurymetoponids, and evidently correlated in some obscure way with the winged condition, in common with the transverse antecoxal grooves. It is interesting, in view of his subsequent change of opinion, that Dr. Horn should have associated *abnorme* originally with *Trimytis*, and in fact described it as a species of that genus. He afterwards very properly founded for it a special genus, but for some very inadequate reasons referred it to the Epitragini, where it is wholly out of place, as shown by the structure of the mentum, as well as by its general habitus. His first impulse in this case was the correct one.

If the language used in describing the punctuation of the head in *abnorme* is at all correct, it differs a good deal from the next three species of the table, but, in any event, as the species are known to be moderately numerous and are unquestionably all very local in habitat, there can be but slight risk of synonymy in the above interpretation of the species; the description of *abnorme* is drawn from the original diagnosis. The enormously elongated terminal joint of the antennæ in *ensifer*, which is founded upon a unique male, raises the question of sexual differences. *Pallidum* is the only species in which both sexes are represented before me, and here the sexual differences in general form of the body and particularly in the development of the

last antennal joint are very pronounced. *Abnorme*, *castaneum* and *brevipenne* are probably represented at present by unique females, and the inference is that in the *abnorme* group of the above table, the last antennal joint is very abnormally developed in both sexes, though especially in the male, while in the *pallidum* group, these departures from the normal are not so pronounced, or, in other words, it is presumable that the last antennal joint of the female in the first group is about as elongated as in the male of the second. In the genus *Prometopion* this abnormality in the terminal joint does not exist at all, as far as we know.

Tribe Trientomini.

A single genus, containing a moderate number of species, confined to the fauna of the Caribbean regions, alone constitutes this tribe so far as now known. Two Mexican species of *Trientoma* were described by Mr. Champion in the "Biologia," but in the appendix of the volume, were considered by that author to have been wrongly labeled and in reality collected in San Domingo. The tribe is a very satisfactory link between the previous tribal groups and the Gnathosiini, and is the only one of the subfamily, except the Epitragini and several with small mentum, occurring in the Caribbean fauna. The genus may be described as follows: —

Body oval, compact, glabrous, wingless, the epistoma strongly produced, narrowed toward base, abruptly and transversely truncate, the mandibles very thick, with a basal swelling fitting into the reëntrant sinus at the base of the epistoma and each with a very thick, strong, obtuse tooth, that of the right slightly the larger and both fitting closely to the epistomal apex when closed, the mandibular apices rapidly though slightly deflexed and feebly bifid at tip; mentum transverse, hexagonal, with the apex feebly sinuate; antennæ rather thick but cylindric, subglabrous, with the outer three joints slightly wider, the eleventh short and obtuse; eyes moderately developed, coarsely faceted, rather prominent and but feebly emarginate anteriorly; prothorax closely fitted to the elytra and as wide at base as the base of the latter; scutellum very minute; elytra finely margined at base, with serial punctures; tibiæ short, broadening from base to apex, the external angle of the anterior not prolonged; tarsi short, thick, the basal joint of the posterior almost as long as the entire remainder; intercoxal process of the abdomen obtuse; metasternum slightly shorter than the first ventral segment..... ....Trientoma

At present this genus is confined entirely to islands between North and South America, but it is probable that it will ultimately be found also in southern Florida.

Trientoma Sol.

The described species are some seven or eight in number; the following appears to differ from any known to me in the books: —

Body stout, evenly elliptical, moderately convex, deep black, the legs scarcely picescent, densely opaque, the surface with extremely minute but strong reticulation, smooth; head wider than long, the supra-orbital carinæ at some distance from the eyes, the surface longitudinally, unevenly and closely strigato-plicate, the carinules converging toward the reëntrant arcs between the epistoma and obliquely rounded sides of the front, extremely minutely, sparsely punctulate throughout; antennæ not extending to the base of the prothorax, the third joint as long as the next two combined, the surface sparsely clothed with inclined yellow setæ; prothorax about half as long as its basal width, the sides converging and feebly, subevenly arcuate from the rather acute and posteriorly subprominent basal angles to the slightly acute but blunt and anteriorly prominent apical angles, the apex three-fourths as wide as the base, deeply and evenly sinuate; base transverse, with a very short broad arcuato-truncate median lobe separated from the general surface by an entire transverse furrow; disk impunctate, extremely minutely and rather sparsely so toward the sides; scutellum narrow, pointed; elytra scarcely a third longer than wide, two and one-half times as long as the prothorax, and, before the middle, very little wider, the sides evenly and broadly arcuate, gradually arcuate and converging in apical half to the acutely ogival apex, the punctures small but distinct, rather coarse laterally, widely spaced in very feebly impressed series which extend to the apex, the interspaces impunctate under a hand lens, the marginal stria deep; abdomen more shining, sparsely, excessively minutely, the basal segment rather less minutely, punctulate, wholly impunctate toward the sides. Length 7.7 mm.; width 3.7 mm. Bahama Islands (Egg Island), — H. F. Wickham.

wickhami n. sp.

The abdomen at base being perceptibly punctate medially but wholly impunctate laterally, contrasts much with any form of the Eurymetoponini, these all having the lateral punctures much coarser than the medial. This is a very interesting discovery by Mr. Wickham and I take pleasure in dedicating the species to him.

Tribe Epitragini.

This extensive tribe is peculiarly North American, although plentifully represented in South America also. It is very clearly delimited from all the other tribes by the form of the mentum, which is transversely parallelogrammic, with the anterior edge broadly, moderately and, as a rule, evenly arcuate. The epistoma is lobed in the middle and the mandibles truncate at tip, the only exceptions known to me being *Epitragus* itself and *Hemasodes*, the former of which is more essentially South American, the epistoma in those genera being emarginate and the mandibles apically bifid, rendering them the most isolated groups of the tribe. The body is in general fully alate, but there are some genera, such as *Conœcus*, which appear to have vestigial wings. The hind body is usually inflated and gradually very acutely pointed behind, and the basal margin of the elytra frequently becomes obsolescent or wanting, but the scutellum is always well developed. The elytral punctures are usually confused or more or less imperfectly serial, although broadly impressed longitudinal lines are frequently evident. The genera known to me may be briefly defined as follows: —

Epistoma broadly emarginate in even circular arc; mandibles bifid at tip 2

Epistoma lobed; mandibles transversely truncate at tip, folding beneath the labrum, the right usually with a dorsal tooth clasping the labrum, the left generally without dorsal tooth 3

2 — Prosternum posteriorly produced, acute at tip and closely received within a large deep mesosternal excavation. South America and eastern Central America. [Type *E. fuscus* Latr.]... * **Epitragus**

Prosternum only slightly produced posteriorly, flattened but obtusely rounded at tip and not quite attaining the mesosternum, which is not excavated; tarsi with pubescent pads beneath, the posterior with the pads very small and apical only, the first joint longer than the fourth. Mexico. [Type *Schœnicus vestitus* Champ.]. * **Hemasodes**

3 — Prosternum horizontally produced posteriorly, the tip received within a large deep mesosternal excavation; eyes large but not prominent, generally finely faceted and but feebly emarginate anteriorly 4

Prosternum slightly produced posteriorly and subhorizontal but not attaining the mesosternum, which is at most feebly or moderately impressed.. 11

Prosternum rapidly deflexed behind the coxæ, conforming with the prevailing type of structure in the subfamily, the mesosternum normal or but feebly impressed..... 12

4 — Tarsi with dense pads of fine pale pubescence beneath..... 5

Tarsi with sparser short, stiff, spiniform setæ beneath, the posterior, at least, devoid of denser and finer pubescence.....10

5 — Pronotum not modified sexually[1].....6

Pronotum remarkably modified in the female; body stout, very obtusely rounded behind..... 9

6 — Head with strong supra-orbital ridges..... 7

Head with very feeble or obsolete supra-orbital carinæ.....8

7 — Body very elongate and acutely pointed behind; lateral lobes of head obliquely prominent; prothorax subtruncate at tip, with the angles obtuse and rounded; basal joint of the hind tarsi fully as long as the fourth. [Type *Epitragus submetallicus* Lec.]. **Polemiotus**

Body very stout, extremely convex longitudinally above, obtuse behind, the lateral lobes of the head not obliquely prominent, the prothorax sinuate at tip, with acute and anteriorly prominent angles; basal joint of the hind tarsi evidently shorter than the fourth. [Type *C. cavicauda* n. sp.] .....* **Cyrtomius**

8 — Body more or less narrow, elongate-oval, acutely pointed behind and moderately convex axially above, the frontal lobes not obliquely prominent except sometimes in the subgenus *Epitragopsis*, the prothorax narrowed and sinuate anteriorly, with the angles more or less acute and anteriorly prominent; basal joint of the hind tarsi shorter than the fourth. [Type *Epitragus fusiformis* Csy.].....**Lobometopon**

9 — Supra-orbital carinæ more or less fine, sometimes nearly obsolete as in the preceding genus; prothorax narrowed anteriorly, sinuate and with acute and anteriorly prominent angles; basal joint of the hind tarsi evidently longer than the fourth. [Type *Epitragus canaliculatus* Say]..... .....**Bothrotes**

10 — Supra-orbital ridges strong, the eyes rather coarsely faceted; body nearly as in *Lobometopon*, but with the basal joint of the hind tarsi at least equal in length to the fourth and generally decidedly longer; sculpture usually coarse and sparse, the surface polished. [Type *Epitragus pruinosus* Horn].....**Metopoloba**

Supra-orbital carinæ apparently wholly obsolete; eyes very minutely faceted; body shorter, stout, broadly oval; basal joint of the hind tarsi evidently shorter than the fourth. [Type *P. subvittatus* n. sp.] ....**Pechalius**

[1] See note under *Lobometopon*.

11 — Body stout and broadly oval as in *Pechalius*, the supra-orbital carinæ similarly obsolete and the surface hairy, the eyes more convex and much less finely faceted, though less coarsely than in *Metopoloba*, the prothorax narrowed and sinuate anteriorly and posteriorly, generally widest at about the middle, with the usual well defined angles; basal joint of the hind tarsi equal in length to the fourth. [Type *Epitragus tomentosus* Lec.]...**Epitragodes**

12 — Anterior tibiæ not abruptly dilated.....13

Anterior tibiæ abruptly dilated within from behind the middle to the apex.....17

13 — Eyes minutely faceted, large but only very feebly convex, subentire as usual, the supra-orbital carinæ very fine or subobsolete; prothorax narrowed and more or less sinuate anteriorly, the angles but slightly advancing; tarsi somewhat variable. [Type *Epitragodes jülichi* Csy.] .....**Phegoneus**

Eyes coarsely faceted, without supra-orbital carinæ.....14

14 — Eyes very convex and prominent.....15

Eyes feebly convex and not prominent.....16

15 — Body elongate-suboval; prothorax widest medially, narrowed to the sinuato-truncate apex, the angles obtuse; anterior and middle tarsi with dense pubescent tufts beneath, the posterior merely with a few short spiniform hairs, the basal joint rather longer than the last; eyes but slightly transversely oval, very minutely, feebly emarginate anteriorly; elytra without evident punctured series. [Type *S. puberulus* Lec.]... .....**Schœnicus**

Body subparallel, the prothorax subquadrate, narrowed but feebly at apex and widest near the middle, the apex truncate; elytra with even series of punctures distinct to the apex. [Type *Schœnicus oculatus* Champ.].....* **Ortheolus**

16 — Body rather broadly oval, wingless or with vestigical wings, the prothorax strongly rounded at the sides, subequally narrowed at apex and base, with the apical angles very obtuse; elytra without series or with very imperfect serial arrangement of the punctures; anterior tibiæ obtusely prolonged externally at tip; all the tarsi with dense silvery-pubescent pads beneath, the basal joint of the posterior much shorter than the fourth. [Type *C. ovipennis* Horn].....**Conœcus**

17 — Body suboval, wingless or with vestigial wings, the prothorax strongly rounded at the sides, subequally narrowed at apex and base and widest at the middle; elytra short as in *Conœcus* and with the punctures confused or very imperfectly lineate in arrangement. [Type *T. atratus* Champ.] .....* **Tydeolus**

Several of the genera in this table, as indicated by asterisks, do not occur in the American fauna and will not in general be

alluded to further in more than an incidental way. *Epitragus*, for example, only extends slightly into Central America from its proper habitat, which is South America.[1] *Hemasodes* (n. gen.), is founded upon the remarkably isolated *Schænicus vestitus*, of Champion. *Orthcolus* (n. gen.), is represented at present only by the neotropical *Schænicus oculatus*, of Champion, while *Tydeolus* Champ., is represented by three rather rare Mexican species, apparently having a good deal the facies of *Conœcus* and probably at least subapterous.

Polemiotus n. gen.

In its strong supra-orbital ridges, prominent and somewhat everted lateral lobes of the front, anteriorly subtruncate prothorax, with rounded angles and elongate body, with widely exposed and rounded humeri, this genus is one of the more distinct of the tribe. The eyes are large and transversely oval, feebly emarginate anteriorly by the rather thick canthus, somewhat prominent and only relatively coarsely faceted, the supra-orbital ridges bounded internally by deep coarse excavations, somewhat as in *Metopoloba*, where the eyes are almost similarly coarsely faceted but less convex. The anterior tibiæ are slender

[1] The following Central American *Epitragus* has been hitherto uncharacterized: —

Elongately fusiform, convex, polished, pale red-brown, the upper surface with scattered recumbent yellow hairs, closer toward the eyes and sides of the pronotum and tending to form denser clusters on the elytra; head rather coarsely punctured, the punctures separated by about twice their diameters medially; prothorax a third wider than long, the sides evenly and moderately arcuate, slightly more so at tip, becoming subparallel in nearly basal half, the basal angles right, not rounded: apex more than three-fourths as wide as the base, the punctures close and small laterally, large and sparse medially, without well defined impunctate line except in basal half, the surface at each side with a large elongate-suboval impression basally at lateral fourth and a transverse feebler impression before the basal lobe, separated from the lateral impressions by a very feeble convexity; elytra three times as long as the prothorax, at base a fifth or sixth wider, the sides broadly arcuate, the tip acute, the humeri rounded; surface with wholly unimpressed series of rather coarse, widely spaced punctures, the intervals with smaller confused punctures, sparse with aggregated denser patches, the entire surface rugose. Length 11.0 mm.; width 4.15 mm. Honduras..... .....* **rigens** n. sp.

I formerly regarded this as *salléi* Champ., but it differs greatly in its unimpressed elytral series and is undoubtedly specifically different.

and straight, with the outer angle at apex minutely and acutely subprominent and the mandibles are densely punctate, with the apical part abruptly impunctate and polished. We appear to have two or three distinct forms which may be described as follows: —

Form elongate-oval, convex, shining, piceous to blackish, with a feeble æneous lustre, the legs concolorous, the antennæ dark rufous, the upper surface with rather long prostrate yellow hairs, evenly distributed but not dense; head quadrate, transversely convex between the intra-ocular excavations, sparsely and rather coarsely punctate, more finely and closely anteriorly and on the epistoma; prothorax but little over a fourth wider than long, the sides straight and feebly converging from the subrectangular and slightly blunt basal angles about to apical third, then more rounding to the apex, the latter truncate and only slightly narrower than the base, the punctures coarse and rather close-set laterally, gradually small and sparse broadly in the middle, the basal lobe strongly rounded; scutellum ogival, nearly as long as wide; elytra twice as long as wide, four times as long as the prothorax, and, at the middle, not quite twice as wide, the sides broadly arcuate, the apex acute, the humeri widely exposed basally and broadly rounded, the punctures slightly coarse and confusedly lineate in very feebly impressed lines, the intervals minutely, sparsely and confusedly punctate; abdomen finely, closely punctulate and pubescent, less shining. Length 13.0–15.0 mm.; width 5.0–5.75 mm. (♂, ♀). Arizona (Baboquivari Mts.)...**submetallicus** Lec.

Form similar, shining, dark piceo-rufous with a very feeble coppery lustre, the legs concolorous, similarly though still less closely pubescent; head nearly similar but more finely and sparsely punctate; prothorax relatively larger, nearly a third wider than long, the sinuato-truncate apex but little narrower than the base, the sides very feebly converging and just visibly, subevenly arcuate from the evident basal angles to the rounded apical angles, slightly more arcuate very near the latter, the surface very broadly and feebly impressed before each of the strong basal sinuations, rather finely, sparsely punctured laterally, extremely finely and remotely so medially; elytra more than twice as long as wide, four times as long as the prothorax, and, at the middle, about three-fourths wider, the sides broadly arcuate, the tip very gradually acute, the humeri widely exposed at base and broadly rounded, with the callus pronounced, very elongate and gradually disappearing posteriorly, the punctures moderately coarse, closely and confusedly aggregated in scarcely impressed striiform lines, the intervals sparsely, confusedly and very minutely punctate. Length 14.5 mm.; width 5.5 mm. (♂). Arizona (Santa Catalina Mts.).
humeralis n. sp.

Var. A — Body nearly similar in form and lustre but broader in the female type, dark rufo-piceous, polished but scarcely with metallic lustre; head nearly similar, the punctures very sparse; prothorax fully two-fifths wider than long, the sides rounding anteriorly, becoming parallel in about basal half, the surface not at all impressed at the basal sinuations, rather finely, sparsely punctured laterally, minutely and remotely toward the middle; elytra similar but more rapidly acuminate and pointed behind, with much more impressed lines of subconfused and rather coarser punctures, the intervals similarly finely punctulate, the humeral callus strong and rounded but more abbreviated. Length 15.5 mm.; width 5.9 mm. (♀). Arizona (Nogales), — H. F. Wickham . .....**acuticauda** n. var.

The female of *acuticauda*, when compared with *submetallicus*, is rather broader, with a larger and more transverse prothorax, which is less coarsely and more sparsely punctate laterally, the elytral humeri rather less broadly rounded and with a larger, more pronounced callus, and the series more impressed. It is probably different specifically from either *submetallicus* or *humeralis*, but, because of lack of series of both sexes, I prefer to consider *acuticauda* as a variety for the present. The Mexican species described by Champion under the name *Epitragus grandis*, will enter the present genus without doubt.

Cyrtomius n. gen.

Besides the characters given in the table to distinguish this genus, its comparatively few members may be known at once by their very distinct facies, due to the obese form, strong convexity of the median part of the body and coarsely wrinkled integuments. Each elytron, in the species known to me, has a small strong protuberance on the disk at the apex, the tubercle being the posterior limit of the acute upper marginal line of the epipleuræ, which do not therefore quite attain the sutural angles. The scutellum is well developed, hairy and rather gradually pointed behind, and the elytra are rather deeply sinuate at the middle of the base, to receive the prominent rounded basal lobe of the prothorax. Three species may be described as follows: —

Elytra very coarsely and irregularly rugose or wrinkled on the subvertical flanks and toward apex, the pubescence more densely aggregated in the depressed parts of the surface 2

Elytra not rugose but with patches of denser pubescence..... 3

2 — Body stout, oval, polished, with strong bronzy lustre, the legs black with strong metallic lustre, the antennæ somewhat piceous; pubescence yellowish, long and suberect anteriorly, dense on the head along the eyes and on the epistoma, rather sparse but very conspicuous on the pronotum, shorter and very unevenly distributed on the elytra and almost wanting on the upper convex parts of the surface; head nearly as long as wide, convex anteriorly (♀) or nealy flat (♂), coarsely and sparsely punctate, closely near the eyes, each lateral lobe isolated by a broad deep groove extending to the apical margin, the epistoma angulate, the eyes large, rather flat, minutely faceted; prothorax three-fourths wider than long, the apex not quite three-fourths as wide as the base, all the angles acute, the anterior very prominent anteriorly, the sides nearly straight, the punctures deep but rather fine, sparse, becoming less sparse but only a little larger near the sides, with an imperfect slightly elevated impunctate median line; elytra between three and four times as long as the prothorax and a third wider, the humeri broadly rounded to the prothorax, the sides feebly sinuate behind them, arcuately converging in apical third, the apex obtuse, the punctures minute and sparse, becoming but slightly larger, though closer and very uneven laterally, confused throughout; sutural region toward apex deeply concave; abdomen minutely punctate, sparsely so and glabrous medially, closely and hairy laterally. Length 12.8–13.8 mm.; width 6.2–6.45 mm. Mexico (Guerrero)..... ...* **cavicauda** n. sp.

Body stout, similar to the preceding in form, color and lustre but smaller and somewhat more densely clothed with long yellowish pubescence, shorter and more appressed on the elytra; head similar but with smaller lateral lobes and shorter antennal joints; prothorax similar but much more finely punctured toward the sides; elytra very finely and closely punctured laterally. Length 12.0 mm. Mexico (Almolonga)..... .....* **plicatus** Champ.

3 — Form elongate-oval, convex, dark æneous, the surface not coarsely and very sparsely punctured; prothorax broader than long, narrowed in front, feebly emarginate anteriorly, the sides feebly rounded from the base, the angles acute, the base strongly bisinuate; elytra with cinereous pubescence arranged in irregular patches, the apex apparently emarginate, the marginal line not extending to the apex but terminating in a small tooth near it, the base emarginate and with a faint impression within the humeri: under surface finely punctured and sparsely clothed with cinereous pubescence. Length 11.5–12.0 mm. Arizona (Camp Grant, — under mesquite bark)..... .....**dentiger** Horn

It is quite possible that *cavicauda*, which is represented before me by a good series, may be identical with the more southern and eastern *plicatus*, but the language used by Mr. Champion in regard to the epistoma and anterior angles of the prothorax

will certainly not apply to the angulate form of the first or the greatly produced acute form of the latter in *cavicauda*. The above short diagnosis of *plicatus* is taken from a specimen recently sent to me by Mr. Champion, from Almolonga. *Dentiger* seems to lose some of the convexity and practically all of the elytral rugosity of the Mexican species, but retains the elytral pubescence in denser patches, as a vestige of the characters developed so strikingly in the more typical forms of the genus. I have not seen it and the description is transcribed from the original. The female of *cavicauda* has the last dorsal segment very remarkably modified, as in the same sex in some forms of *Hylocrinus*, of the Eurymetoponini; this segment is black and densely chitinized, with a very deep median emargination, from the bottom of which projects a slender sagittiform process; in the male the last dorsal is coriaceous and pale as usual, narrow, with the apex truncate, the penultimate being more broadly arcuato-truncate and with a very small simple median sinus. There is no sexual difference in the modification of the elytral apices, this being one of the most important of the distinguishing generic characters. The Mexican *inæqualis*, of Champion, also belongs to *Cyrtomius*, without much doubt.

Lobometopon n. gen.

This genus is a large one and extends in range from Utah and Kansas, at least to the Isthmus of Panama and probably further, although replaced to a large extent by *Epitragus*, and some other allied genera, in South America. The species are evenly elongate-oval in form, evenly convex and either uniformly pubescent or glabrous, with the eyes large but flattened, finely faceted and with very feebly developed supra-orbital carinæ, the lateral lobes of the front never separated from the median parts by more than a feeble depression, the apical angles of the prothorax always anteriorly prominent and the elytra gradually acutely ogival toward apex. The upper line of the epipleuræ extends to the sutural angle, which is usually unmodified but sometimes feebly mucronate, apparently more especially in the female; the elytra sometimes have broadly and feebly impressed lines, particularly toward the suture, and, toward tip, two or

three of these grooves are generally a little stronger, but this is the only modification that I have noted, except a very minute truncature of the apical angles in a few species such as *godmani* Champ., and the sexes differ but little, as a rule, the female merely being a little stouter in form, with the anterior parts usually more closely punctured. In the following table I have included a few neotropical species which happen to be represented in my cabinet: —

Upper line of the epipleuræ attaining the acute sutural angles; anterior angles of the prothorax prominent and acute, elytra with confused sculpture at least laterally; eyes finely faceted. [*Lobometopon* in sp.]..... 2

Upper line of the epipleuræ not attaining the sutural angles, the elytral apex conjointly narrowly truncate or feebly sinuate; anterior angles of the prothorax anteriorly prominent but blunt; elytra with confused sculpture; eyes finely faceted. [*Epitragoma* n. subg.]....15

Upper line of the epipleuræ not quite attaining the sutural angles but terminating in a minute denticle near it, the apices individually minutely, obliquely truncate; elytra with even series of punctures which are not at all confused laterally; anterior thoracic angles acute but not very prominent; lateral lobes of the front more prominent, the eyes coarsely faceted. [*Epitragopsis* n. subg.]...16

2 — Body glabrous or with inconspicuous vestiture.....3

Body with distinct pubescence.....14

3 — Head without occipital depressions.....4

Head with a marked impression at each side of the occiput near the eyes, at least in the female.....13

4 — Pronotal punctures more or less fine and sparse medially..... 5

Pronotal punctures decidedly coarse throughout.....10

5 — Anterior angles of the prothorax not much deflexed 6

Anterior angles greatly deflexed, almost as in *ovalis*..... 9

6 — Pronotum without an impunctate median line or with this line narrow and very imperfect..... 7

Pronotum with a distinct impunctate median line.....8

7 — Form narrowly fusoid, moderately convex, highly polished with strong æneous lustre, the pubescence very short and sparse, inconspicuous though easily observed; head rather coarsely, sparsely punctate, more closely toward the eyes and anteriorly; prothorax only about a third wider than long, moderately narrowed from the acute and prominent basal angles to the acute and strongly anteriorly prominent apical angles, the sides very feebly arcuate, generally becoming slightly sinuate near both angles, the surface very minutely and sparsely punctate, becoming somewhat coarsely but still sparsely so laterally, with a feeble elongate-oval impres-

sion before the scutellum, the latter wider than long and very obtusely ogival; elytra elongate, very gradually and acutely pointed behind, the angles acute but not mucronate, the humeri broadly rounded to the prothorax, the surface with a few feebly impressed lines suturally, very finely, sparsely punctured, less finely but not very closely laterally, the punctures confused but with some traces of slightly larger punctures, either in irregular single series or in longitudinal aggregated lines. Length 10.0–11.0 mm.; width 4.0–4.25 mm. Mexico (Guerrero) ..... * **gracile** Csy.

Form elongate-ovoidal, moderately convex, deep black with scarcely any metallic lustre, rather shining, the pubescence very short, sparse and inconspicuous; head somewhat finely and sparsely punctate, the punctures coarser, dense and coalescent toward the orbital carinæ, which are fine but distinct, the epistoma ogivally rounded; prothorax about a third wider than long; the sides moderately converging from the base, broadly and rather strongly arcuate, becoming feebly sinuate near the basal and apical angles, the former slightly acute, sharp and feebly everted, the latter acute, slightly everted, prominent and with the tip only slightly blunt; surface feebly convex, somewhat flattened medially toward apex, where the anterior margin is just visibly elevated at each side of the flattened area, the punctures not very coarse but strong, impressed and moderately sparse medially, without trace of an impunctate line, becoming gradually decidedly coarse and close but not dense laterally; elytra elongate, nearly two-thirds longer than wide, very gradually ogivally acute posteriorly, about three times as long as the prothorax but barely a fifth wider, the sides arcuate, strongly and abruptly rounded at the humeri to the thoracic angles, the humeri somewhat exposed at base, the callus short but large and rather prominent, the punctures fine but strong, rather sparse, becoming but little larger and still well separated laterally, the impressed lines wholly obsolete; abdomen finely, rather closely punctulate medially. Length 10.0 mm.; width 4.15 mm. Mexico (Guadalajara), — Rolle..... ..... * **aberrans** n. sp.

Form rather narrowly fusoid, convex, shining, black with very feeble bronzy lustre, the tarsi piceous, the pubescence extremely short and conspicuous; head rather coarsely, densely punctured, the antennæ rather stout, the tenth joint nearly twice as wide as long; prothorax rather short, almost one-half wider than long, strongly narrowed anteriorly, the apex about two-thirds as wide as the base, the sides evenly and notably arcuate, the basal angles very acute and minutely prominent, the apical acute and anteriorly prominent, the surface with a small and obsolescent impression on the basal lobe, strongly and much less finely, somewhat sparsely punctate, becoming gradually densely but not much more coarsely so laterally, with traces of an impunctate line anteriorly; scutellum transverse, broadly ogival, anteriorly declivous; elytra oval, much more obtusely ogival apically, the sides arcuate and the humeri broadly

rounding to the base of the prothorax, at the middle fully two-fifths wider than the prothorax, the punctures rather small and sparse but strong, becoming not much larger but close-set laterally, confused but with traces of slightly larger punctures in series, the sutural broadly impressed line distinct apically, the sutural angles acute but not mucronate; abdomen polished, rather finely but not very sparsely punctured medially. Length 9.0 mm.; width 4.0 mm. Utah (Marysvale),— H. F. Wickham.....**uintanum** n. sp.

8 — Form elongate-oval, convex, shining, black, without metallic lustre except a feeble steel-blue tint on the pronotum, subglabrous; head moderately coarsely, perforately and closely punctate, the tenth antennal joint obtriangular, about a third wider than long; prothorax rather elongate, scarcely more than a fifth wider than long, the apex fully three-fourths as wide as the base, the sides very evenly and moderately arcuate throughout, the basal angles right, not at all prominent, the apical acute and anteriorly prominent, the surface strongly but rather sparsely punctured, becoming gradually somewhat coarsely, densely so laterally, with a narrow and subentire impunctate line, not impressed near the base; scutellum transverse, very obtusely ogival, convexly declivous anteriorly; elytra gradually but rather obtusely ogival in apical two-fifths, the sides becoming subsinuate behind the humeri, which are broadly rounded to the thoracic angles, at the middle fully two-fifths wider than the prothorax, the punctures not very coarse but strong, not larger but dense laterally, confused though with the feeblest traces of larger punctures aggregated into partial lines suturally, the sutural angles simple, acute; abdomen strongly and closely punctured medially and slightly shining, the basal segment more sparsely punctured. Length 11.0 mm.; width 4.5 mm. Arizona..... .....**fusiforme** Csy.

Form still more narrowly fusoid, naviculate, convex, polished, somewhat piceous-black, with very feeble bronzy lustre, the pubescence extremely short and very inconspicuous; head strongly but not very coarsely punctured, loosely so medially but densely and rugosely laterally, finely but strongly and closely apically, the epistoma angulate, with the angle slightly prominent; prothorax nearly as in *fusiforme* but with the broadly arcuate sides usually becoming slightly sinuate before the basal angles, which are somewhat acute and prominent, the apical acute and anteriorly prominent, the surface finely, rather sparsely punctured, becoming strongly but not very coarsely and closely though not densely so laterally, the punctures at the extreme edge decidedly smaller than at about lateral fourth or fifth; scutellum transversely ogival, declivous only at base; elytra gradually very acute in apical two-fifths, with only very feebly and rather finely impressed lines suturally, the sides arcuate, the humeri gradually rounding to the thoracic angles, at the middle about a third wider than the prothorax, the punctures decidedly coarse and very strong, rather well separated,

not larger but closer and shallower laterally, confused and with but the feeblest possible traces of disconnected series; abdomen polished, æneous, finely but strongly, sparsely punctured, more coarsely and closely so only very near the sides. Length 9.5–10.0 mm.; width 3.8–4.1 mm. Arizona, — Warren Knaus.

symmetricum n. sp.

Form shorter and stouter, oval, strongly convex, polished, piceous-black with faint bronzy lustre, the pubescence extremely short, sparse and inconspicuous; head rather finely but strongly, closely punctate, less densely medially, the supra-orbital carinæ distinct, the surface feebly impressed along them internally, the epistoma angulate; antennæ nearly as in *fusiforme;* prothorax more transverse than in the two preceding species, nearly a third wider than long, the form nearly similar, the sides evenly and moderately arcuate throughout, the basal angles right, the apical acute and produced, the surface finely but strongly, sparsely punctured, gradually becoming densely and notably coarsely so laterally but finer at the edge than at some distance therefrom as in *symmetricum;* scutellum similar, impunctate; elytra rather rapidly and arcuately narrowed in apical third, the sides arcuate, the humeri rounded and slightly exposed at base, with the callus unusually pronounced, the surface with rather distinctly impressed lines suturally, the punctures very fine and sparse, becoming much larger and closer but still well separated laterally, confused though with rather obvious series of larger punctures, irregularly single suturally but becoming wider aggregations laterally as in *gracile;* abdomen rugosely punctured broadly toward the sides, finely and rather sparsely medially. Length 9.3–10.0 mm.; width 4.2–4.7 mm. Arizona (southern), — F. H. Snow.

pimalicum n. sp.

Form still shorter, almost similarly stout, strongly convex, polished, dark piceous-brown with faint æneous lustre; head rather coarsely and densely punctate, more sparsely so at the centre of the vertex, the epistomal lobe large, ogivally rounded; prothorax (♂) a fourth wider than long, the sides evenly converging from the base, broadly, subevenly arcuate, the apical angles somewhat acute, but slightly prominent, the basal a little more than right, slightly blunt, not everted, the surface evenly convex, rather finely, sparsely punctate medially, gradually somewhat coarsely and closely so laterally; prothorax (♀) a little more transverse, similar but with the punctures much more close-set throughout, becoming only moderately separated medially; elytra rather rapidly ogivally acute in apical third, much wider than the prothorax and about three times as long, the humeri obliquely and moderately rounded to the thoracic base, with the callus short but pronounced, the surface with obsolete impressed lines suturally, more evident in the female, the punctures rather fine and sparse suturally, somewhat coarse and close-set but shallow and some-

what scabrous laterally; abdomen minutely, rather sparsely punctured medially, polished. Length 8.5–10.0 mm.; width 3.7–4.5 mm. Arizona (Oak Creek Canyon), — F. H. Snow.
æneopiceum n. sp.

Form narrowly fusoid, convex, much smaller than any of the preceding species, blackish-piceous, polished, with a moderate æneous lustre; head rather finely, moderately closely punctate, more coarsely and coalescently toward the eyes, the epistoma large, broadly ogival; prothorax a fourth wider than long, the sides evenly and rather strongly arcuate, becoming sinuate before the moderately acute and everted basal angles and more convergent and straight at the apical angles, which are acute, not at all blunt or everted and only moderately prominent, the surface evenly convex, finely and sparsely punctured medially, gradually densely and somewhat coarsely so laterally, the punctures near the sides separated by nearly their own widths; scutellum moderate, broadly ogival; elytra elongate, very gradually ogivally acute posteriorly from behind the middle, the sides rapidly rounded at the humeri, which are exposed at base, rather less than three times as long as the prothorax and much wider, the punctures only moderately fine, somewhat sparse and irregular suturally, decidedly coarse, close and asperulate, though shallow as usual, laterally, the impressed lines obsolete; abdomen strongly and not very finely, somewhat closely punctured medially. Length 8.2 mm.; width 3.4 mm. Arizona (Douglas, — Cochise Co.), — F. H. Snow.....**docile** n. sp.

9 — Body rather narrowly oval (♂), stouter and somewhat dilated behind the middle (♀), strongly convex, moderately shining, the elytra rather dull, black without distinct metallic lustre, the pubescence extremely short and inconspicuous; head rather finely, densely punctate, more sparsely in a small area at the middle of the vertex, each puncture with a small brilliantly silvery seta, the tenth antennal joint nearly one-half wider than long, much more strongly rounded on the inner than the outer side; prothorax less than a fourth wider than long, but little narrowed anteriorly, the apical angles rather obtuse from above but normally acute and anteriorly prominent from an oblique anterior viewpoint, much deflexed, the basal angles somewhat more than right and not at all prominent but not rounded, the sides evenly and moderately arcuate; surface strongly, transversely convex anteriorly, rather finely but strongly, moderately sparsely punctate, becoming coarsely and densely so laterally, each puncture with a small silvery seta, the median line impunctate except near the apex and base; scutellum slightly transverse, somewhat tumid, rounded; elytra rather rapidly acuminate with strongly arcuate sides in apical third, the apical angles acute and simple, the sides arcuate, the humeri very gradually rounded to the thoracic base, at the middle a fourth (♂) to two-fifths (♀) wider than the prothorax,

the punctures moderately coarse, rather close-set, still closer and larger but shallow laterally, confused, the feebly impressed lines with rather denser but very obscure aggregations of punctures; abdomen rather strongly and closely punctured medially. Length 9.0–9.6 mm.; width 3.85–4.5 mm. Arizona.

propinquum n. sp.

10 — Median impunctate line of the pronotum very narrow, subelevated, only visible at and behind the middle. Body suboval, strongly convex, somewhat shining, black with a feeble coppery to greenish metallic lustre, each puncture with a small silvery hair; head rather coarsely, extremely densely and subrugosely punctate throughout; prothorax rather more than a fourth wider than long, but little narrowed anteriorly, the apex about four-fifths as wide as the base, with the angles rather strongly deflexed though very acute and anteriorly prominent from an oblique viewpoint, the basal angles slightly less than right, with thickened marginal bead and very slightly prominent, the sides subevenly but very feebly arcuate; surface coarsely, perforately punctate, the punctures separated by but little more than their own diameters medially, becoming still coarser and dense laterally, smaller and extremely dense at the edges; scutellum tumid, impunctate, angulate posteriorly; elytra rather rapidly and arcuately narrowed at tip, with the angles simple and acute, the sides arcuate to the obtusely subangulate humeri, which are very narrowly exposed at base, at the middle fully two-fifths wider than the prothorax, the surface with broad and feebly impressed lines throughout the width, very finely but rather closely punctate suturally, more coarsely and densely laterally, confused throughout, without traceable series; abdomen finely but strongly, closely punctate medially. Length 8.7–10.7 mm.; width 3.9–4.9 mm. New Mexico and Kansas.....**cribricolle** n. sp.

Median impunctate line normal, flat, extending almost to apex and base 11

11 — Form broadly fusoid, strongly convex, small in size, not very shining, black with obscure bronzy lustre, without metallic lustre beneath; hairs borne by the punctures extremely small; head trapezoidal, densely and deeply, rather coarsely punctured throughout, the antennæ stouter than usual, the club broad; prothorax relatively small, nearly a third wider than long, the apex three-fourths as wide as the base, with the angles not unusually deflexed, acute but only moderately prominent anteriorly, the basal angles right and not prominent, the sides very evenly and rather strongly arcuate throughout; surface coarsely, closely punctured throughout except in a limited area behind the middle, where the punctures are more scattered, densely crowded laterally; scutellum but little wider than long; elytra unusually inflated, with strongly and evenly arcuate sides, gradually and arcuately narrowed in apical two-fifths, the humeri obtusely angulate, very slightly exposed at

base, at the middle almost one-half wider than the prothorax, the surface finely, closely punctate, more coarsely and densely so laterally, without distinct impressed lines, the punctures confused throughout, the sutural angles very acute but simple; abdomen finely rugulose, finely but closely punctured medially. Length 8.5 mm.; width 3.7 mm. Kansas..... **jucundum** n. sp.

Form more narrowly elongate-oval, strongly convex.....12

12 — Body strongly shining, piceous-black with distinct æneous lustre, each puncture bearing a small but very evident cinereous hair; head not very coarsely but closely, evenly punctured, the punctures separated by about their own widths near the middle, the antennæ moderately slender; prothorax relatively small, the apex but little more than two-thirds as wide as the base, with the angles rather strongly deflexed though very acute and anteriorly prominent when viewed subanteriorly, the basal right and not prominent, the sides evenly and distinctly arcuate, the surface strongly but only moderately coarsely, rather closely punctate, the punctures separated by nearly twice their own widths medially, becoming but slightly larger but deep and close though not at all crowded laterally; scutellum moderate; elytra oblong, rather rapidly and arcuately narrowed in about apical third, the sides moderately arcuate to the rounded humeri, which are rather widely exposed at base, at the middle fully one-half wider than the prothorax, the punctures very fine but deep, sparse, becoming larger but shallow and still well separated laterally, with but the feeblest evidences of larger seriate punctuation suturally, the impressed lines almost wanting, slightly evident apically near the suture, the sutural angles very acute but simple; abdomen feebly rugulose, rather finely, not very sparsely and strongly punctured medially. Length 9.8 mm.; width 4.6 mm. Utah (St. George), — H. F. Wickham. **parvicolle** n. sp.

Body moderately shining, the upper surface with strong bronzy lustre, the under surface with scarcely any metallic reflection, each puncture bearing an extremely minute and wholly inconspicuous hair; head closely, rather coarsely, deeply punctate, more finely anteriorly; prothorax long, well developed, scarcely a fifth wider than long, the apex three-fourths as wide as the base, with the angles not much deflexed, very acute and anteriorly prominent, the basal slightly acute and prominent, the sides evenly but rather feebly arcuate; surface not coarsely but deeply, rather closely punctate, the punctures separated by rather more than twice their own widths medially, becoming only moderately coarse but deep and very close-set laterally; scutellum well developed, transverse, rounded, flat and impunctate; elytra gradually acute and with moderately arcuate sides in nearly apical two-fifths, the sides broadly arcuate, more rounding at base to the obtuse humeri, which are very narrowly exposed at base, the surface without trace of impressed lines except one along the suture toward tip,

the punctures rather fine and well separated but strong, becoming dense and rather coarse laterally, confused, with scarcely any evidence of series, the sutural angles simple but very acute; abdomen smooth, finely, moderately closely punctured medially. Length 10.5 mm.; width 4.75 mm. Arizona...**æquipenne** n. sp.

Body moderately obese and shining, colored like the preceding, the tibiæ slightly rufescent, the punctures bearing similar very minute and inconspicuous hairs; head rather coarsely, closely punctate, subconfluently so laterally, more finely toward apex; prothorax fully a fifth wider than long, the apex but little more than two-thirds as wide as the base, the sides feebly arcuate, becoming broadly sinuate toward the apical angles, which are not greatly deflexed, very acute and anteriorly produced, the basal angles right and not prominent; punctures coarse and deep, separated by about one-half more than their own diameters medially, becoming very coarse and longitudinally subconfluent laterally, finer and dense near the edges; scutellum large, flat, impunctate, angulate behind; elytra rather rapidly and arcuately narrowed to the acute tip, the sides broadly, evenly arcuate to the obtuse humeri, which are evidently exposed at base, the surface with broadly and feebly impressed lines almost throughout the width, strongly, not very finely and rather closely punctured, densely and rather coarsely toward the sides, the punctures confused but becoming rather coarser and broadly aggregated in the impressed lines, although not very evidently so; abdomen smooth, not very finely, strongly, rather sparsely punctured medially. Male narrower, blacker and more sparsely punctured than the female, to which the description refers. Length 10.0–11.0 mm.; width 4.3–4.8 mm. Arizona (near the southern boundary and San Bernardino Ranch, Cochise Co.).—Morrison and Snow.

morrisoni n. sp.

13 —Form rather stout, oval, moderately convex, polished, glabrous, black with strong cupreous lustre, the antennæ nearly black, the legs dark piceo-rufous; head densely, deeply and rather coarsely punctate, the basal excavations very deep and cavernous, the epistoma broadly, obtusely angulate; prothorax nearly one-half wider than long, the apex rather more than two-thirds as wide as the base, with the angles rather deflexed, acute and produced anteriorly, the sides broadly arcuate, becoming more converging and broadly sinuate anteriorly and straight or just visibly sinuate near the basal angles, which are acute and slightly prominent; punctures dense but not crowded toward the sides and apex, coarse toward the former, fine toward the apex, more scattered toward the middle posteriorly and with a partial flat impunctate line; scutellum ogival, about as wide as long; elytra gradually acutely pointed behind in apical two-fifths and gradually declivous on the disk, the sides feebly arcuate, more strongly rounded at base to the thoracic angles, the punctures confused, rather fine but strong,

sparse, becoming rather coarse but still well separated laterally, with regular unimpressed series of rather coarse punctures suturally, which become confused with the other punctures laterally; surface impressed near the sutural angles, which are very acute and slightly mucronate; under surface polished, with greenish metallic lustre, the abdomen somewhat finely and sparsely but strongly punctured medially. Length 13.0 mm.; width 5.5 mm. Nicaragua (Ometepe), — Shimek.....*bicaviceps n. sp.

Form nearly similar, less stout, glabrous, polished, black with bright coppery-bronze lustre, greenish beneath, the legs dark piceo-rufous; head rather finely but deeply, very densely punctate throughout, the occipital pits much shallower and triangular in form, the epistomal lobe broadly parabolic; prothorax nearly similar, fully two-fifths wider than long, the apex nearly three-fourths as wide as the base, with the moderately deflexed angles very acute and anteriorly prominent, the sides feebly arcuate or feebly subangulate before the middle, scarcely visibly sinuate anteriorly, the basal angles right, not at all prominent, the punctures only very moderately coarse and slightly separated laterally, becoming fine medially, close-set anteriorly but sparse posteriorly, with a partial impunctate line, the basal lobe strongly rounded, not at all impressed; scutellum similar; elytra similar in form and about a fourth wider than the prothorax, finely, sparsely and confusedly punctate, more coarsely and densely but unevenly so laterally, with the unimpressed series composed of only slightly larger, widely spaced punctures and not at all conspicuous; under surface almost similar. Length 13.0 mm.; width 5.1 mm. Panama (Natá).....*alveolatum n. sp.

14 — Form oval, somewhat inflated posteriorly, very convex, subopaque from density of sculpture, dark red-brown to blackish in color, the legs not paler, devoid of metallic reflection, the pubescence decumbent, yellowish-cinereous, short but dense; head trapezoidal, somewhat coarsely, very closely punctate; prothorax two-fifths or more wider than long, very convex, the apex fully three-fourths as wide as the base, with the angles greatly deflexed though acute and slightly prominent, with the apex deeply and evenly sinuate between them from an oblique anterior viewpoint, the sides very feebly converging and but slightly arcuate in about basal two-thirds, then rapidly rounding to the apex, the basal angles abruptly and minutely prominent, the surface somewhat coarsely, very closely punctate, extremely densely but not more coarsely laterally, without impunctate line; scutellum well developed, polished, rounded behind; elytra shorter than usual, but little more than two and one-half times as long as the prothorax, and, at the middle, a third wider, rapidly narrowed to the acute apex, the sides strongly, evenly arcuate to the humeri, which are not exposed, the callus very small and feeble, the surface smooth, without distinct impressed lines, rather finely but deeply, very

closely punctured throughout, a little more coarsely so laterally, without trace of series; abdomen somewhat shining, finely, not very closely punctate medially. Length 9.0–9.8 mm.; width 4.2–4.6 mm. Texas. [= *Epitragus ovalis* Csy.]...**ovale** Csy.

Form nearly as in *ovale* but more elongate, very strongly convex, dark piceous, moderately shining, the elytra duller, the pubescence cinereous, short but rather abundant and distinct; head somewhat coarsely, densely punctate, with the merest trace of fine orbital carinæ, the epistomal lobe large, rather acutely angulato-ogival; prothorax not quite a third wider than long, the apex three-fourths as wide as the base, the sides subevenly and feebly arcuate, becoming more converging and subsinuate anteriorly, the angles much deflexed, acute, not blunt and moderately prominent, not everted, the basal angles acute and very slightly everted; surface evenly and strongly convex, not very finely, perforately and not very closely punctate, with a narrow smooth line medially, gradually not very coarsely but very densely and coalescently so laterally; elytra three-fifths longer than wide, barely three times as long as the prothorax and two-fifths wider, subinflated behind the middle, thence gradually acutely ogival to the tip, the sides less arcuate basally, the humeri obtusely subangular and very slightly exposed at base, the callus narrow and very feeble, almost obsolete; surface with very feebly impressed lines suturally, strongly, not very finely and moderately closely punctate, more coarsely, rather densely and asperulately so laterally; abdomen shining, minutely, rather closely punctulate medially. Length 9.5 mm.; width 4.2 mm. Kansas (Wallace Co.)..... .....**obscurum** n. sp.

Form somewhat as in the female of *Bothrotes canaliculatus* Say, but with the prothorax more convex, plumbeo-æneous, almost opaque, clothed with short cinereous pubescence; head densely punctate; prothorax almost one-half wider than long, narrowed anteriorly, the sides rounded, the apical angles subacute and not at all prolonged, the surface finely and densely punctate; elytra densely punctulate and rugose, somewhat obsoletely striate. Length 10.0 mm. Kansas. [= *Epitragus plumbeus* Lec.]...**plumbeum** Lec.

15 — Body rather stout, elongate, fusiform, convex, polished, dark piceous or blackish with very strong æneous lustre, the tibiæ, tarsi and antennæ rufescent; pubescence rather long, subdecumbent, nearly white, moderately close; head coarsely, sparsely punctured, more closely laterally and anteriorly, the epistoma broadly, angularly lobed, the lateral lobes very small, rounded, the labrum impressed along the middle and clothed with long silky hairs; supra-orbital carinæ completely obsolete; prothorax one-half wider than long, strongly narrowed, the apex about three-fifths as wide as the base, with the angles right, but little produced and evidently rounded, the sides evenly and moderately arcuate throughout, the basal angles right, not prominent but not rounded, the surface not coarsely but strongly, sparsely punctate, but little more coarsely

though rather closely so very near the sides; scutellum rounded, fully as long as wide, pubescent; elytra gradually narrowed to the narrowly truncate tip in apical two-fifths, the sides feebly arcuate, more strongly rounded at the humeri to the thoracic angles, at the middle about a fourth wider than the prothorax; surface without impressed lines, except one along the suture toward tip, minutely punctate, the punctures arranged in a few alternating broad stripes, in which they are very sparse and rather closely aggregated, less evident laterally, where the punctures become slightly larger and closer and with the surface minutely rugulose, the side margin finely serrate; abdomen with long white pubescence not concealing the surface, minutely, not closely punctate medially. Length 12.0 mm.; width 5.0 mm. Arizona. [= *Epitragus vestitus* Csy.].....**vestitum** Csy.

16 — Body rather narrowly elongate-fusoid, moderately convex, glabrous, polished, black, the elytra somewhat piceous, strongly æneous in lustre, with scarcely metallic lustre beneath, the legs dark piceous; head rather coarsely and strongly, somewhat sparsely punctured, the lateral lobes of the front rounded but almost as anteriorly prominent as the epistomal lobe; eyes much more coarsely faceted than in any of the preceding species, the supra-orbital carinæ fine; prothorax nearly one-half wider than long, the apex broadly sinuate, two-thirds as wide as the base, the angles but slightly acute and not very much advanced though not at all blunt, the sides almost evenly but rather feebly arcuate, very slightly sinuate just before the basal angles, which are somewhat acute and prominent, the punctures fine and sparse, becoming slightly coarse but still widely separated laterally, without impunctate line except feebly at base; scutellum ogival, as long as wide; elytra very gradually acutely pointed and gradually declivous in apical two-fifths, the sides feebly arcuate, abruptly rounded at base to the thoracic angles, a third wider than the prothorax, the punctures minute, very sparse and confused throughout the width, with nine even, entire and unimpressed series of moderately coarse, deep, rather well separated punctures, not at all confused or larger toward the sides; abdomen smooth, finely and sparsely but strongly punctured medially. Length 11.5 mm.; width 4.38 mm. Panama (Natá).....* **godmani** Champ.

The genus *Lobometopon* proper includes, besides the American species above described, most of the Mexican and Central American sexually similar forms with lobed epistoma, recently made known by Mr. Champion in the "Biologia." *Epitragoma* and *Epitragopsis* are treated as subgenera in the table, though I have but little doubt that they will ultimately be regarded as true genera. The latter is, like *Epitragus*, a purely South American group, only penetrating Central Amer-

ica for a short distance beyond the Isthmus of Panama, and the type described above under the name *godmani*, agrees with Mr. Champion's description, except that the lateral lobes of the front are described as diverging; they are in no sense everted in the specimen described above, but have their external sides internally rounding anteriorly; *communis* Champ., is a closely allied species and I have another still smaller, represented by two specimens from Espirito-Santo, Brazil. The singular cephalic characters of *bicavicceps* and *alvcolatum* may possibly relate only to the females of the *cuprcus* type, to which they evidently belong. *Epitragoma*, represented in our fauna at present by a single species, includes also the Mexican *Epitragus chevrolati* and possibly also *pilosus*, of Champion; it seems to be purely Sonoran in habitat. The left antenna in the unique type of *uintanum* becomes gradually pale testaceous toward tip, the right antenna being black throughout, — a singular malformation. In *aberrans* there is a feeble modification of the apical part of the prothorax, reminding us of the male of the next genus, but this cannot be regarded as a transitional character; it is related to *metallicus*, which is out of place in the arrangement of the "Biologia," but differs in the much more transverse prothorax.[1]

[1] Since this was written I have received from Mr. Champion, good series of examples of forms related to *metallicus* and *cupreus*, from various points in Mexico and Central America. These specimens shed much light on the difficulties and uncertainties attending generic delimitation in this part of the Epitragini, for it is quite evident that the females of some of the closely allied forms of the *metallicus* group, have pronotal characters similar in form to those of *Bothrotes*, although so feeble in development as to indicate that these characters in *Lobometopon* may simply be atavistic or reversional in nature. One of the chief peculiarities of *Lobometopon* consists in the acutely and gradually pointed form of the body posteriorly; this is as well developed in the *metallicus* group as in the more typical species and, even though some females of that group have two feeble pronotal ridges and a very slightly thickened lateral margin, it is to be noted that these ridges never extend to the apical margin or interrupt the continuity of the latter as they do in *Bothrotes*. I am therefore of the opinion that the *metallicus* group cannot be held to unite the genera *Lobometopon* and *Bothrotes*. The specimens of the *cupreus* group before me show rather conclusively that the excavation behind each eye, alluded to in the above table, is a sexual character affecting the female. Attending this character we have finer and denser punctures of the head and of the pronotum, especially toward the apex and sides of the latter. There are a good many species belonging to both the *metallicus* and *cupreus* groups, but the material sent me seems to show that those made known in the present paper are distinct from those described by Mr. Champion in the "Biologia."

Bothrotes n. gen.

This is the largest genus of the Epitragini in North America and is possibly the most isolated in general facies. The remarkable sexual discordance in the structure of the prothorax has but few parallels in the Coleoptera, the pronotum of the female having two prominent longitudinal ridges, evanescent toward base, the space between them and between each and the side margins concave and the lateral margins thickened. In the male, not only are the ridges obsolete and the side margins very fine, but the entire sculpture is generally coarser. The ridges are not absolutely obsolete in the male, being traceable by two inequalities of the anterior margin, and, sometimes, by a flattening of the disk. The body is shorter and stouter, as a rule, than in *Lobometopon* and more obtusely rounded at the posterior extremity, but the tarsi have the same dense pads of pubescence and the frontal parts of the head and the sternal structure are similar. The fine simple upper margin of the epipleuræ attains the sutural angles but at a considerable distance within the lower margin, which becomes more outwardly prominent near the angles, with the intermediate surface deeply grooved, and the united tips of the elytra are protected and sunken partially below the upturned edge of the last ventral segment. The only modification on the posterior declivity of the elytra, is a slight concavity between the one or two somewhat accentuated ridges separating the usual broadly impressed lines, so characteristic of the tribe in general, together with a few series of small, widely spaced asperities, which also appear in some of the Eurymetoponini. The eyes are flattened and minutely faceted; the supra-orbital carinæ are very fine or subobsolete and the anterior angles of the prothorax acute and anteriorly prominent. The species are difficult to tabulate because of deficiency in salient structural divergencies, but those in my cabinet may possibly be recognized by the following descriptions: —

Species larger in size, always strongly bronzed.....2

Species smaller, less metallic as a rule and generally darker in coloration 6

2 — Pronotum (♂) rather strongly impressed along the median line. Body elongate-oval, strongly convex, bright coppery-bronze in

lustre above and beneath, the pale pubescence long, not concealing the surface but very conspicuous; head coarsely, rather closely punctate, more finely and densely on the large angulate epistoma, with an impunctate spot at the middle of the occiput; prothorax (♂) large, not a third wider than long, the apex two-thirds as wide as the base, with the angles acute and produced but not very slender and not everted, the sides perfectly straight, excepting for a space from the middle nearly to the apex where they are feebly arcuate, the basal angles acute but not everted, the surface perceptibly tumid at each side of the middle anteriorly, strongly, somewhat coarsely, rather sparsely punctate, more coarsely and closely so laterally, with an impunctate median line; elytra oval, obtusely rounded behind, at the middle nearly one-half wider than the prothorax, the sides arcuate, more strongly rounding at base to the thoracic angles, rather finely but strongly, sparsely punctate, scarcely more coarsely but more closely laterally, with very feebly impressed longitudinal lines throughout; abdomen strongly, closely punctured. Length 13.0 mm.; width 6.0 mm. Florida (Key West) ..... **fortis** n. sp.

Pronotum (♂) at most only feebly impressed along the median line.3

3 — Supra-orbital carina obsolete or scarcely traceable.....4

Supra-orbital carina rather distinct though fine; body only moderately large and unusually narrow..... 5

4 — Form stout, oblong-oval, convex, rather strongly shining, dark bronzed in lustre, the pubescence shorter than in *fortis*, conspicuous but not at all concealing the integument; head moderately coarsely and closely punctate, the epistomal lobe rounded; prothorax (♂) two-fifths wider than long, with the apex four-fifths as wide as the base, the angles acute, prominent, prolonged and everted, the sides feebly arcuate, the basal angles slightly everted but not very sharp, the surface almost even, rather coarsely, closely punctured laterally, more finely and sparsely medially; prothorax (♀) smaller, more transverse, trapezoidal, with the sides nearly straight and with the greatly thickened margin dilated in the middle, the apical angles more acute but not everted, the ridges very strong, the surface more finely and sparsely punctate, with a fine carina along the middle in the concavity between the ridges; elytra nearly three-fifths longer than wide, the sides parallel and feebly arcuate, rounded at base, almost smooth and with scarcely visible impressed lines suturally, not coarsely but strongly, rather closely punctate, somewhat more coarsely, closely and with the surface more chagrined laterally; abdomen finely, closely punctate and with short pale pubescence. Length 12.4–12.8 mm.; width 5.8–6.1 mm. Texas (Columbus and Luling). [= *Epitragus acutus* Lec.]..... .... **acutus** Lec.

Form stout, nearly as in *acutus* but with much coarser and rougher sculpture, strongly bronzed, rather dull, the pubescence somewhat longer, more plentiful and more shaggy; head closely, moderately

coarsely punctured; prothorax (♂) large, not quite one-half wider than long, the apex three-fourths as wide as the base, the angles much prolonged anteriorly but scarcely at all everted, the sides evenly and distinctly arcuate, the basal angles acute and everted, the surface almost even, rather coarsely, closely and subevenly punctured throughout, without evident impunctate line; prothorax (♀) trapezoidal, smaller, with nearly straight sides which are very widely thickened except toward apex, the sculpture and ridges nearly as in *acutus;* elytra conspicuously and coarsely rugose, rather coarsely, closely punctured, densely but less deeply toward the sides, the broad impressed lines feeble; abdomen shining, minutely, not very closely punctulate medially. Length 11.8–12.8 mm.; width 5.7–6.0 mm. Texas..... .....**subrudis** n. sp.

Form much narrower than in either of the preceding species, elongate-oval, strongly convex, rather shining, brilliant bronze in lustre, the pubescence short, cinereous and not dense; head closely, rather coarsely punctured, the epistoma finely but not very densely, broadly angulate; prothorax (♂) two-fifths wider than long, the apex three-fourths as wide as the base, with the angles narrowly prolonged, prominent and strongly everted, the sides rather strongly arcuate, becoming feebly sinuate toward the basal angles, which are acute and slightly prominent, the surface rather finely and sparsely punctate, more coarsely and closely so laterally, nearly even, with a well marked, obsoletely impressed impunctate line; elytra oblong-oval, parallel and feebly arcuate at the sides, strongly rounded at base to the thoracic angles, the surface somewhat coarsely, irregularly plicato-rugose, finely, strongly, not very closely punctate suturally, less finely, closely and rugosely so laterally, the impressed lines wide and feeble but evident; abdomen minutely rugose and strongly, rather closely punctate medially. Length 11.3 mm.; width 5.2 mm. Texas (Del Rio), — H. F. Wickham.

pensus n. sp.

5 — Body elongate-oval, strongly convex, polished and strongly æneous or viridi-æneous, the pubescence short and rather sparse; head rather finely, moderately closely punctured, the epistomal lobe large, angulate; prothorax (♂) about a third wider than long, of the same form as in the preceding species, the sides feebly arcuate, the apical angles very acute and sometimes feebly everted, the basal acute and prominent, the surface sometimes with a feeble narrow tumorosity at each side of the middle anteriorly, finely but strongly, rather closely punctate, more coarsely, rather densely so laterally; prothorax (♀) of the same general form and sculpture as in *acutus;* elytra oblong-oval, with feebly arcuate sides, strongly rounded at base to the thoracic angles, at the middle much wider than the prothorax, the impressed lines wide and strong, the punctures minute and sparse suturally, still fine but close-set, with the surface less shining laterally; abdomen finely, feebly rugulose and finely, rather sparsely punctate medially.

Length 10.7–11.8 mm.; width 4.6–5.3 mm. Kansas (Pratt Co.), — Warren Knaus..... .....**knausi** n. sp.

6 — Epistomal lobe very sharply triangular, with the sides straight; integuments distinctly metallic in lustre.. 7

Epistomal lobe obtuse and either ogival or rounded; lustre generally not or feebly metallic..... 8

7 — Body elongate-oval, convex, the elytra brownish-testaceous, the lustre throughout very bright æneous, the surface polished; pubescence sparse but distinct, rather conspicuous on the male pronotum; head sparsely, moderately coarsely punctured, more closely laterally, finely but not densely on the epistoma, the orbital carinæ distinct (♀) or obsolescent (♂); prothorax (♀) small, transverse, trapezoidal, with the two ridges very strong, becoming unusually prominent anteriorly, the general surface very finely, sparsely punctate; prothorax (♂) much larger, less transverse, with the sides more rounded, the surface nearly even, less finely but sparsely punctured medially, somewhat coarsely and less sparsely laterally; scutellum tumid, rounded, metallic; elytra much wider than the prothorax, especially in the female, with distinct, rather narrowly impressed lines, minutely, sparsely punctate, less minutely but still finely and rather sparsely and with the surface only a little less shining toward the sides; abdomen rather finely but strongly, only moderately sparsely punctate medially. Length 8.3–9.8 mm.; width 3.6–4.2 mm. New York to Texas (near the sea-beaches).....**arundinis** Lec.

Body not very stout, convex, more oblong-oval, polished, the elytra duller, especially toward the sides, black, the elytra less deeply, the legs and antennæ deep black, the lustre viridi-æneous anteriorly and beneath, scarcely metallic on the elytra, the legs nonmetallic; vestiture short and inconspicuous; head rather finely, very sparsely punctured medially and but little less sparsely anteriorly, more coarsely but still loosely toward the eyes, where the carinæ are distinct and sharply elevated even in the male; prothorax (♂) nearly one-half wider than long, trapezoidal, with feebly arcuate sides which are not at all sinuate anteriorly, the apex fully three-fourths as wide as the base, with the angles acute and not at all blunt but not in the least everted, the basal angles acute and very feebly everted, the surface even, rather finely but strongly, sparsely punctured, less sparsely toward tip, not very coarsely, perforately and still sparsely laterally, except along the immediate edges where the punctures are a little closer but not dense; scutellum rather large, rounded; elytra oblong, obtuse behind, with very feebly arcuate sides, strongly rounded at base, at the middle about a third wider than the prothorax, with feeble but distinct impressed lines, minutely, sparsely punctured suturally, still rather finely but more closely and shallowly so laterally; abdomen rather finely but strongly, not very sparsely punctured medially; female unknown. Length 10.0 mm.; width 4.8 mm. Texas (near El Paso) .....**æneicollis** n. sp.

Body moderately stout and convex, shining, bright brassy or bronze, the cinereous pubescence fine, rather short and sparse and moderately conspicuous; head moderately coarsely, deeply, evenly and somewhat closely punctate, obtusely elevated at the middle of the vertex, the epistoma broadly angulate with straight sides, the orbital carinæ sharply elevated; prothorax (♀) rather small, three-fifths wider than long, almost evenly trapezoidal, the sides straight, excepting a very feeble swelling before the middle, the apical angles very acute, narrowly prolonged and feebly everted, the basal very acute, sharp and not everted, the thickened margin even, narrowed only anteriorly; ridges rather narrow and moderately elevated, straight and parallel, obsolescent near the base, the apex between them broadly sinuate, the depression moderate, gradually evanescent toward the base; punctures fine and rather sparse, with a narrow distinct and subentire smooth line medially, still rather fine but closer laterally; elytra very obtusely rounded behind, two-fifths wider than the prothorax and two and one-half times as long, the sides strongly rounded at base; surface with broadly and moderately impressed lines suturally and finely but rather closely punctured, with coarser punctures in the furrows, larger and dense, shallow and asperulate laterally; male unknown. Length 9.7 mm.; width 4.5 mm. Texas (Alpine), — H. F. Wickham ..... **chalceus** n. sp.

8 — Head (♀) very opaque and feebly impressed across the base of the vertex, where the punctures become very fine; supra-orbital carina fine but strong and acutely elevated at least in the female..9

Head (♀) not notably more impressed or differently sculptured entirely across the base of the vertex, more shining and more coarsely sculptured..... 10

9 — Pronotal ridges (♀) arcuate anteriorly, the inclosed depression more rounded. Body stout, deep black throughout, shining but without metallic lustre, the pubescence extremely minute and scarcely discernible; head finely, rather closely and very evenly punctured, slightly shining, the transverse depressed band behind the vertex densely opaque and finely, more sparsely punctate, each puncture with a short silvery hair, the occiput convex, the epistoma very broadly and obtusely ogival; prothorax (♀) transverse, fully three-fifths wider than long, trapezoidal, with very feebly arcuate sides becoming slightly sinuate near the apical angles, which are very acute but not much produced, the thickened margin unusually fine, thick near the base, where the angles are right and not at all prominent; ridges broadly convex, very feeble and subobsolete behind the middle, interiorly oblique anteriorly, moderately prominent at apex, the general surface alutaceous, rather finely but deeply, not very sparsely punctate, more coarsely and a little less sparsely so laterally, impunctate along a fine line adjoining the thickened edge except toward base; scutellum moderate, acutely ogival, as long as wide; elytra broad, oblong, one-

half longer than wide, the sides feebly arcuate, strongly rounding at base, at the middle two-thirds wider than the prothorax, the impressed lines obsolete except suturally toward tip, where they are strong as usual, the punctures fine, sparse, becoming slightly coarse and closer but shallow, with the surface but little less shining, laterally, having also some very feebly defined and irregular disconnected lines of larger punctures suturally; abdomen shining, with rather small but strong, somewhat close-set punctures and with the surface feebly rugulose medially. Length 10.5 mm.; width 5.3 mm. Arizona (Seligman), — H. F. Wickham.....**tenebrosus** n. sp.

Pronotal ridges (♀) parallel and straight or virtually so. Body stout, oblong-oval, convex, shining, black, the upper surface with a feeble and more grayish lustre, the under surface feebly viridiæneous; pubescence extremely short and very inconspicuous; head elongate, only moderately coarsely but deeply, densely and subevenly punctate, finely and sparsely in the more opaque area before the transversely tumid occiput, the epistoma strongly ogival, with the sides but slightly arcuate; prothorax (♀) not quite one-half wider than long, trapezoidal, with the sides very feebly, evenly arcuate from the rectangular and non-prominent basal angles anteriorly, becoming obviously sinuate behind the very acute, prolonged and everted apical angles, the thickened margin subequal throughout and minutely, densely punctate; ridges rather narrowly elevated, becoming broad and feeble posteriorly, the surface alutaceous, finely, loosely punctate, rather coarsely and somewhat closely laterally, with a very fine impunctate line along the margin in apical half, and another, along the median line and not attaining the apex, flat as in *tenebrosus* and not at all elevated; elytra as in *tenebrosus* but more elongate, nearly smooth, at the middle not more than one-half wider than the prothorax, the impressed lines broad and subobsolete on the disk, the punctures rather coarse, deep and close-set, becoming still coarser, dense and subscabrous laterally; abdomen as in *tenebrosus*. Male with the head and prothorax more coarsely but closely punctate, the latter relatively rather small, with the anterior angles produced and prominent. Length 10.0–10.8 mm.; width 4.8–5.2 mm. Arizona (Tucson)..... **occipitalis** n. sp.

10 — Body narrowly oval in form, somewhat as in *arundinis* and *æneicollis*..... 11

Body stout in form..... 14

11 — Integuments black, with a dull bronze lustre.....12

Integuments without metallic lustre.....13

12 — Form moderately narrow, convex, moderately shining, with very short inconspicuous pubescence; head somewhat longer than wide, rather coarsely, very closely punctate, the epistoma broadly and obtusely ogival; prothorax (♂) one-half wider than long,

the apex three-fourths as wide as the base, with very feeble and broadly sinuato-truncate lobe, the angles acute, produced and everted, the basal angles right, not at all everted or prominent, the sides evenly and feebly arcuate to the sinus behind the apical angles; surface rather coarsely, very deeply and closely punctate medially, very densely so but not more coarsely laterally, more finely at about lateral fourth and at the sides, not distinctly bi-impressed at base; elytra barely one-half longer than wide, three times as long as the prothorax and a fourth wider, rapidly obtusely ogival posteriorly, the sides broadly, evenly arcuate to the humeri, which are not exposed at base, the callus very feeble, the punctures only moderately small, deep and rather close-set suturally, larger but shallow, dense and subscrabrous laterally, with very obsoletely impressed lines including some coarser punctures suturally; female unknown. Length 10.6 mm.; width 4.9 mm. Arizona.....**confertus** n. sp.

Form similar but more depressed, more shining, the elytra with greenish-bronze lustre, the pubescence very short and inconspicuous; head nearly as wide as long, rather coarsely, closely punctate, the epistomal lobe large, much produced, very obtusely ogival; prothorax (♂) rather less than one-half wider than long, the apex a little more than three-fourths as wide as the base, with the lobe very feeble, truncate, the angles rather thick, somewhat blunt at tip, much produced and strongly everted, the basal angles slightly acute but not everted, the sides straight, becoming very feebly arcuate before the middle to the post-angular sinus, the surface very distinctly impressed near each side at base, rather coarsely, closely punctate, finely and very densely so at lateral fourth and near the edge, coarsely and less densely intermediately, without impunctate median line; elytra fully one-half longer than wide, a little more than three times as long as the prothorax and almost a third wider, very rapidly and obtusely ogival at tip, the sides broadly arcuate, more rapidly rounded at base to the thoracic angles, the callus moderately prominent; surface wholly devoid of trace of impressed lines, unusually coarsely, deeply and closely punctate, scarcely more coarsely but more shallowly and moderately closely so laterally; female unknown. Length 9.5 mm.; width 4.3 mm. Arizona..... **eversus** n. sp.

Form more narrowly elongate-oval, more convex than in *eversus* and less shining, the pubescence very short, inconspicuous; head as wide as long, only moderately coarsely and not very closely punctate, the epistomal lobe broad and angulato-ogival, the sides less arcuate than in the preceding species; prothorax (♂) a little more than one-half wider than long, the apex as in *eversus*, with the lobe feeble and sinuato-truncate, the angles very different, short, not produced, very feebly everted and scarcely prominent though acute and not blunt, the basal angles and sides as in *eversus*; surface finely, rather sparsely punctate medially, a little

more coarsely and less sparsely near lateral fifth but elsewhere laterally more finely and closely, the median impunctate line distinct and well defined except anteriorly; elytra fully two-thirds longer than wide, much less rapidly and less obtusely ogival at tip than usual, the sides broadly arcuate, gradually a little more strongly so basally, the callus feeble; disk three and one-half times as long as the prothorax and barely a fifth wider, wholly devoid of broadly impressed lines, a very fine line near the suture sometimes visible, finely, rather sparsely punctured suturally and with feebly marked lines of slightly coarser punctures, a little larger but shallow and well separated laterally; female unknown. Length 10.0 mm.; width 4.4 mm. New Mexico (Fort Wingate). **affinis** n. sp.

Form nearly as in *eversus*, moderately convex, shining, the pubescence a little longer, rather evident; head moderate, coarsely, closely punctate, the epistomal lobe large, moderately produced, very obtusely ogival; prothorax (♀) one-half wider than long, the sides very evenly and feebly arcuate from the acute but not prominent basal angles to the small and acute, not much produced and uneverted apical angles, the thickened margin gradually broader toward base, the ridges moderate, unusually widely separated anteriorly, short, evanescent near the middle, the inclosed depression broad and feeble, the punctures rather small and sparse, larger and closer laterally, the impunctate line distinct nearly to the apex; elytra nearly one-half longer than wide, more than three times as long as the prothorax and nearly two-fifths wider, very obtusely subparabolic at tip, the arcuate sides more strongly rounded at base, the punctures not very fine, deep and moderately close, becoming a little larger, shallow but well separated laterally, the surface wholly devoid of impressed lines except the usual impressions on the apical declivity; male unknown. Length 9.0 mm.; width 4.4 mm. New Mexico (Sta. Fé Canyon).—F. H. Snow..... .....**pertinax** n. sp.

13 — Black, the elytra very dark brownish-piceous to blackish, the pubescence not long but conspicuous, the surface moderately shining, head nearly as in *affinis* but with the epistoma more prominent and much less obtuse; prothorax (♂) evidently less than one-half wider than long, trapezoidal, with broadly and feebly rounded sides, becoming slightly more converging and feebly sinuate near the angles, which are very acute and not at all blunt but not produced, the basal angles very acute and slightly everted, the surface strongly flattened in nearly median half, the sides of the flattened part slightly tumid anteriorly and the apical lobe pronounced, the punctures not decidedly coarse but deep and moderately separated, becoming very close-set and still coarser laterally, the median line narrowly impunctate except anteriorly; scutellum rather rounded behind, wider than long; elytra obtusely ogival at tip, the sides broadly arcuate, more rounded at base, a

third to two-fifths wider than the prothorax, with broadly impressed but very evident longitudinal lines throughout the width, the punctures rather coarse, deeply impressed and close-set, becoming but little larger, dense, shallow and scabrous laterally; abdomen closely and strongly punctured and finely, strongly rugulose medially. Length 9.0–10.3 mm.; width 4.1–4.6 mm. New Mexico (Sta. Fé Canyon).....**picipennis** n. sp.

Black throughout, convex, moderately shining, the pubescence very short but rather distinct; head moderate, coarsely, moderately closely punctured, sparsely so medially (♂) or less coarsely, more closely and evenly so (♀), the epistoma obtusely ogival, more rounded in the latter sex; prothorax (♂) one-half wider than long, trapezoidal as usual, the sides subevenly and feebly arcuate, feebly sinuate behind the apical angles, which are not much produced but very acute and slightly everted, the basal angles acute, not at all everted; surface sensibly elevated and flattened anteriorly, the lobe very feeble, slightly sinuate, the punctures strong but sparse medially, coarse and closer near lateral fifth, smaller and dense near the edges, the median smooth line distinct; prothorax (♀) nearly similar in outline and size, the sides similarly arcuate, the post-angular sinus subobsolete, the angles almost similar, very acute but not much prolonged, the basal angles acute, not at all everted, the thickened margin subequal throughout, the ridges moderate, short, obsolescent near the middle, the inclosed depression rather feeble, the punctures fine and sparse, only a little less fine and sparse laterally; elytra one-half longer than wide to rather more, much wider than the prothorax, the sides more strongly rounded at the humeri, the callus feeble, the surface without evident impressed lines, finely and very sparsely punctate suturally, somewhat coarsely but feebly and not densely so laterally. Length 9.3–10.5 mm.; width 4.2–4.8 mm. Arizona (Ash Fork). **secutor** n. sp.

Var. A — Body (♂) nearly as in *secutor* and with similar smooth elytra, unusually remotely punctured suturally, somewhat less slender in form, the head less coarsely, more densely and uniformly punctured, the prothorax not evidently flattened anteriorly, more closely punctured throughout, somewhat impressed on the median line before the middle and with the basal angles very evidently everted. Length 9.8 mm.; width 4.6 mm. New Mexico (Galisteo). — F. H. Snow.....**apertus** n. var.

14 — Color piceous, always paler on the elytra.....15

Color deep black, sometimes with a very faint bronze lustre.....16

15 — Body rather stout, moderately shining, dark piceous, the anterior parts black with a very faint metallic lustre, the pubescence very short and inconspicuous; head (♂) coarsely, deeply and not very closely punctured centrally, densely and less coarsely laterally and anteriorly, or less coarsely, closely and uniformly so (♀), the

epistoma obtusely, ogivally rounded; prothorax (♂) three-fifths wider than long, moderately narrowed apically, the sides rather strongly rounded at the middle, becoming more converging and feebly sinuate anteriorly and obsoletely sinuate near the basal angles, which are acute and slightly everted, the apical angles acute and very feebly everted but not prolonged anteriorly, the surface medially flattened near the apex, the lobe rather evident, the punctures somewhat coarse but sparse medially, also very coarse and well separated at about lateral fifth, smaller and dense laterally, where there is a feeble impression of the surface at about the middle of the length; prothorax (♀) almost similar in form and size, the sides feebly arcuate near apical third, thence straight to the base, more converging and feebly arcuate to the apex, the angles small, acute, not in the least everted, the basal angles not everted, the ridges straight, obsolescent at the middle, the intermediate depression moderate, the punctures fine and sparse, with the impunctate line more complete than in the male, rather coarse and close-set laterally; elytra one-half longer than wide, less in the female, obtuse at tip, the side more rounded at the humeri, the surface with broad and feebly impressed lines, rather finely but strongly, somewhat closely punctate, feebly and closely, shallowly so laterally. Length 10.0–10.3 mm.; width 4.6–4.8 mm. New Mexico (Magdalina Mts. and Fort Wingate).

acomanus n. sp.

Body very stout, oblong-oval, moderately convex and shining, piceous, the elytra pale brownish, the pubescence short but cinereous, abundant and rather conspicuous; head rather coarsely, closely punctured, or less coarsely and more densely (♀), the epistoma broadly, ogivally rounded; prothorax (♂) one-half wider than long, of the usual form, the sides feebly arcuate medially, becoming very obsoletely and broadly sinuate apically and basally, the apical angles acute and prominent, very feebly everted, the basal somewhat bluntly acute and just visibly everted, the surface very feebly flattened discally, except toward base, the anterior lobe vestigial, the punctures not coarse but strong, moderately sparse, with imperfect smooth line medially, decidedly coarse but not dense near lateral fifth and fine and dense at each side of the latter areas as usual; prothorax (♀) a little smaller and more transverse, the sides almost straight, with broadly thickened margin, the apical angles very finely acute and slightly everted, the basal very acute but scarcely everted, the ridges very strong, obsolescent near the base, somewhat converging posteriorly, the depression strong, the punctures minute and sparse, still very fine and sparse laterally; elytra two-fifths to one-half longer than wide, very obtuse at tip, the sides strongly rounded at base to the thoracic angles, the surface with broadly impressed lines, becoming obsolete in the male, strongly, rather closely punctate, more closely, coarsely and muricately but shallowly toward the sides. Length 9.7–10.5 mm.; width 4.5–5.2 mm. Colorado, — Cab. Levette.

neglectus n. sp.

16 — Female with long and generally pronounced parallel and moderately separated dorsal pronotal ridges, evanescent only near the base 17

Female with short, more or less feeble ridges, evanescent near the middle 18

17 — Body small in size, moderately slender and convex, shining, deep black, without metallic lustre except a feeble greenish tinge on the elytra; head rather coarsely, confluently punctate toward the eyes, less closely along the middle, which is unusually convex; prothorax (♀) small, transverse, rather more than one-half wider than long, trapezoidal, the sides nearly straight, the apical angles very acute and not blunt but not prolonged, the basal acute but not everted, the ridges strong, straight, extending almost to the base, the surface deeply concave in the middle anteriorly, finely, rather sparsely punctate, less finely and very closely laterally, the thickened margin subeven in width; scutellum parabolic; elytra barely one-half longer than wide, obtuse at tip, the sides arcuate, abruptly and strongly rounded at base, at the middle almost two-thirds wider than the prothorax, the surface with feeble and broadly impressed lines throughout, finely but strongly, rather closely punctured, more coarsely, shallowly, densely and scabrously toward the sides; abdomen minutely, unusually sparsely and very inconspicuously punctulate medially; male unknown. Length 8.5 mm.; width 4.0 mm. Kansas..... **insitus** n. sp.

Body much larger, rather dull in lustre as a rule, grayish-black, sometimes with a feeble bronze lustre, the pubescence short but rather abundant and distinct, cinereous; head densely and moderately coarsely punctate in both sexes, the epistomal lobe very broadly ogival; prothorax (♂) more than one-half wider than long, moderately narrowed at apex, the sides rather strongly, subevenly arcuate, sinuate behind the apical angles, which are moderately acute and prominent, everted, the basal angles acute and more or less everted, the surface almost evenly convex, the apical lobe very feeble, the punctures fine but strong, moderately sparse, with the smooth line imperfect, becoming not very coarse but close near lateral fifth and finer and very dense near the edges; prothorax (♀) nearly similar in form and size, the sides very feebly arcuate, the basal angles acute but not everted, the apical acute but not evidently everted, the thickened margin broader basally, the ridges strong, moderately separated, the inclosed impression extending behind the middle, the punctures fine and sparse, only a little less fine but rather close-set laterally; elytra oblong, obtuse behind, much wider than the prothorax and more than three times as long, the sides strongly rounding at base, the surface with broadly and feebly impressed lines as a rule, finely and rather closely punctate, not very coarsely, closely and asperulately so laterally. Length 10.0–12.0 mm.; width 4.7–5.7 mm. Colorado (Colorado Springs), Kansas, New Mexico (Magdalena Mts., Sta. Fé Canyon and Albuquerque) and Texas (Alpine and El Paso).

canaliculatus Say

Body less stout and smaller than in *canaliculatus*, deep black with a moderate, scarcely metallic lustre, the pubescence short, sparse and rather inconspicuous; head not very coarsely and only moderately closely punctured, the epistomal lobe parabolic and very obtuse; prothorax (♂) large, two-thirds wider than long, the apex barely three-fourths as wide as the base, the sides absolutely evenly and strongly arcuate from the apex of the basal to the apex of the apical angles, the latter abbreviated, acute but only slightly prominent, the basal but slightly less than right; surface almost evenly convex, barely perceptibly and broadly flattened medially, the apical lobe very broad and feeble, the punctures fine but strong, very sparse, with a partial smooth line medially, slightly coarse but well separated laterally and scarcely smaller though denser at the edges; prothorax (♀) very much smaller in size and fully as transverse, trapezoidal, with the sides virtually straight, slightly sinuate behind the apical angles, which are finely acute and just visibly everted, the basal very acute but not everted, the thickened margin rapidly broader basally, the ridges not very strong, convex, the intervening depression only moderately deep, the punctures rather fine, sparse, with a distinct smooth line, decidedly coarse and rather close-set laterally; elytra nearly as in *canaliculatus* but with the punctures very fine and sparse suturally, with the coarser punctures in the impressed lines somewhat obvious, especially in the female, coarser but shallow, not rough and only moderately close laterally. Length 10.8 mm.; width 4.8–4.9 mm. Arizona (Ash Fork), — F. H. Snow.....**funebris** n. sp.

18 — Form moderately stout, convex, shining, black, with a pronounced bronze lustre, the pubescence very short, sparse and inconspicuous; head moderately coarsely, not very densely punctate centrally, more finely and closely elsewhere, the epistoma obtusely ogival; prothorax (♀) rather less than one-half wider than long, the apex fully four-fifths as wide as the base, the sides subevenly and very feebly arcuate from the moderately acute and uneverted basal angles to the feeble sinus behind the apical angles, the latter acute, somewhat prolonged, slightly everted and prominent, the thickened margin broader toward base, the surface abruptly flattened medially toward base, the ridges moderate, parallel, obsolescent behind the middle, the anterior depression very feeble, scarcely more than flattened, the punctures fine and sparse, with a subentire smooth line medially, moderately coarse and closer laterally, becoming dense near the sides; elytra nearly as in *canaliculatus* but almost one-half wider than the prothorax, with very obsoletely and broadly impressed lines suturally, the punctures fine and sparse, with coarser punctures in the depressed lines, coarser and close-set, shallow but submuricate laterally; male unknown. Length 10.5 mm.; width 4.9 mm. Arizona (San Bernardino Ranch, Cochise Co.), — F. H. Snow..... .....**perditus** n. sp.

Form very stout, polished, deep blue-black in color, without trace of

metallic lustre, the pubescence very short, sparse and inconspicuous; head rather coarsely and sparsely punctured centrally, finely and sparsely in the transverse subbasal depression somewhat as in *tenebrosus* and *occipitalis*, the coarse punctures longitudinally confluent toward the fine but pronounced orbital carinæ, the epistoma very obtusely and ogivally rounded; prothorax (♀) three-fifths wider than long, very shining, the apex three-fourths as wide as the base, the sides feebly and evenly arcuate from the acute and uneverted basal angles to the apex, becoming nearly straight anteriorly, the apical angles small, acute, anteriorly prominent but not much prolonged and not at all everted, the thickened margin broader basally, densely punctulate as usual; ridges rather strong, parallel, feebly arcuate and very short, obsolescent at about the middle, the depression distinct behind the elevated anterior margin, the latter on a level with the crests of the ridges; punctures rather coarse, deep, very sparse medially though becoming very fine and closer near apex and base, moderately fine but deep, evenly distributed and not very close-set laterally; elytra nearly as in *canaliculatus*, two-fifths wider than the prothorax and more than three times as long, the humeri strongly rounded, the punctures notably coarse, very deep and unusually close-set, with scarcely impressed lines of still coarser punctures suturally, becoming but little coarser though dense, shallow and asperulate laterally; male unknown. Length 11.8 mm.; width 5.6 mm. Arizona (San Bernardino Ranch, Cochise Co.), — F. H. Snow.

amplificans n. sp.

Form very stout, shining, deep black, without metallic lustre, the pubescence extremely fine, sparse and scarcely visible, the hairs barely extending beyond the limits of the punctures; head moderately coarsely, loosely punctate medially, more closely laterally and apically, the punctures not coalescent toward the carinæ, which are all but completely obsolete in both sexes; epistomal lobe angularly ogival; prothorax (♀) large, three-fifths wider than long, the apex fully three-fourths as wide as the base, the sides very feebly, subevenly arcuate, becoming just visibly sinuate toward the apical angles, the latter acute with the tip blunt, moderately prominent and very feebly subeverted, the basal angles acute, blunt at tip and not distinctly everted, the thickened margin only very feebly elevated, much thickened at the apical and basal angles; ridges broad and very feeble, parallel, obsolete at about the middle, the impression very feeble behind the subelevated anterior margin, the punctures nearly as in *amplificans* but with the finer medial punctures at apex and base much sparser; prothorax (♂) still larger and less transverse, the surface evenly convex and more coarsely and closely punctate, somewhat sparsely medially, with an incomplete smooth line, the apical angles sharply acute but only moderately prominent and scarcely everted, the basal very sharply acute and evidently everted, the sides similarly evenly and feebly arcuate; elytra rather shorter than usual, with

more angulate humeri, only a fourth wider than the prothorax and more than three times as long (♀) or much less (♂), with the impressed lines feeble suturally (♀) or obsolete (♂), the punctures rather coarse and moderately close suturally, not coarser and but little closer laterally though less deep. Length 10.5–11.0 mm.; width 4.9–5.3 mm. Mexico (Guadalajara), — Rolle.

* **obsolescens** n. sp.

The singular structure of the upper surface of the head by which *tenebrosus* and *occipitalis* are separated, is essentially a female character but is never so pronounced or accompanied by so much impression, opacity or reduction of the punctuation elsewhere, as far as noted, although traceable in such obese forms as *amplificans*. It may be also noted, in this connection, that the supra-orbital carinæ are generally fine and feeble, sometimes subobsolete, but that they are almost always much more developed in the female than in the male. The prothorax varies sometimes rather conspicuously in size within the same sex, as for example in *neglectus*, where in one female before me it is fully two-thirds as wide as the elytra and in another, much smaller, only a little more than half the width of the elytra; it may be observed also that the prothorax may be subsimilar in size and outline in the two sexes or may be smaller in the female than in the male, in *arundinis* and *funebris* very remarkably so, while in *acomanus* and *secutor* it is broader and somewhat larger in the female than in the male.

In the single apparently mature female of *subrudis*, a probably accidental character, analogous to that noticed before in the case of *Lobometopon uintanum* occurs, both antennæ being very pale flavo-testaceous, becoming gradually piceous toward base and contrasting greatly with the uniformly black antennæ of the male. The female of *pensus*, received since the original description of that species was written, is remarkably aberrant; it is stouter than the male, the prothorax flattened medially at apex, the flattened part deeply emarginate at apex, with the sides obliquely, anteriorly projecting and prominent, each prolonged longitudinally backward in a small feeble ridge, obsolete before the middle, each ridge bordered internally by a feeble oval impression; there is nothing else like it known to me and it has no appearance of being a sport or monstrosity. The single female

of *funebris* also possesses a structure which is unique as far as known, but which may be a malformation, the epistomal lobe, instead of being large and projecting, is very small, not more than a third as wide as the front, the front being equally trilobed and deeply bisinuate, the central lobe projecting but slightly beyond the lateral; there is no indication of this peculiar structure in the male, so that it may be accidental in this individual. *Apertus* may prove to be a species distinct from *secutor*, but, as it is founded upon a single specimen and resembles that species considerably, I deem it more prudent to regard it as subspecific for the present. *Canaliculatus* is represented before me by a very large series, giving a good opportunity to observe the limitations of intraspecific variability, and it may be stated that this inconstancy is very pronounced in color, lustre, development of the thoracic ridges of the female, and depth of the impression between them, well developed to obsolete impressed lines of the elytra and in some other characters; a very large series collected at Alpine, Texas, by Mr. Wickham, is particularly useful in this study. It is highly probable that these extreme variations may indicate some well defined subspecies, but the material at hand is not sufficient to confirm this surmise. This species is said, by Say, to occur also in Pennsylvania, but he doubtless confounded *arundinis* with his western species, as the true *canaliculatus* does not occur east of the 100th meridian. I cannot find the species described above under the name *obsolescens*, among those made known by Mr. Champion in the "Biologia," and conclude that it is abundantly distinct, its closest ally apparently being *rorulentus* Champ.

Metopoloba n. gen.

In this genus the body is elongate, fusiform and nearly similar in the sexes, much as in *Lobometopon*, differing superficially in its polished, subglabrous, sparsely and more coarsely sculptured integuments, prominent supra-orbital carinæ, not so much larger in themselves but rendered very prominent by reason of the broad, deep grooves bounding them internally, in the much less prominent and generally obsolete apical angular projections of the prothorax and in having the tarsi spinose beneath, the

anterior and intermediate with small and less conspicuous tufts of coarse dense pubescence, the posterior without trace of finer hairs and with the first joint notably longer than the fourth in many cases. The mandibles are both squarely truncate at tip and hollowed internally at apex, the mentum strongly transverse and coarsely sculptured and the scutellum well developed; the upper margin of the epipleuræ attains the sutural angle, not there more retired than the lower margin as in the preceding genus, but posterior to it, with the intervening surface similarly deeply concave; the upper marginal line is not a smooth carina but is punctured along its crest, sometimes coarsely, and, very near the sutural angle, rapidly descends toward the lower margin. The female is generally a little stouter than the male. The species are not so numerous as those of the two preceding genera, those before me being separable as follows:—

Abdomen coarsely, closely punctured and shining medially.....2

Abdomen finely, densely punctate and more or less opaque medially..4

2 — Cephalic grooves extending to the frontal margin. Body stout, oval, strongly convex, polished, black with a slight piceous tinge above; head coarsely, irregularly and not very closely to sparsely punctured; prothorax transverse, one-half wider than long, trapezoidal, with the sides nearly straight from above, broadly arcuate viewed sublaterally; apex four-fifths as wide as the base, unmargined and truncate but becoming feebly sinuate and margined laterally, with the angles slightly obtuse but not rounded, the basal angles acute but not everted, the surface moderately convex, even, obsoletely and broadly impressed near the base, with rather coarse, sparse and impressed punctures, closer anteriorly, becoming very coarse but well separated laterally and again less coarse and very close on the shallow subvertical flanks near the finely reflexed side margins; scutellum much wider than long, large, broadly angulate behind; elytra broadly arcuate at the sides to the obtuse but only slightly blunt humeri, which are very narrowly exposed at base, slightly widest behind the middle, the apex gradually, acutely ogival, the surface feebly impressed along the suture posteriorly, with very sparse punctures, generally small but varying in size suturally, becoming coarse but still sparse laterally, confused throughout; abdomen densely, rugosely punctured. Length 11.0 mm.; width 5.22 mm. (♀). Nevada (Reno).

bifossiceps n. sp.

Cephalic grooves not extending to the frontal margin.....3

3 — Form stout, convex, polished, blackish-piceous thoughout, the short recumbent hairs of the anterior parts more noticeable than

usual; head coarsely, subevenly and rather closely punctured; prothorax less transverse than in *bifossiceps*, two-fifths wider than long, subsimilar in form, the sides evenly, feebly arcuate from above, the apex very feebly sinuate throughout but only margined laterally, the angles slightly obtuse and bluntly rounded, the basal angles right and very slightly prominent, the punctures coarse and somewhat sparse throughout the length medially, gradually still coarser but equally sparse laterally, becoming close and smaller in the feeble sublateral basal impressions and near the side margins; scutellum rather small, about as long as wide, ogival; elytra widest rather behind the middle, gradually somewhat acutely ogival behind, the sides broadly arcuate, becoming more strongly rounded near the very obtusely subangulate humeri, which are but little exposed basally, the surface impressed within the humeral callus and in two or three shallow sutural grooves posteriorly, rather coarsely, unevenly, sparsely punctured suturally, but little more coarsely though less sparsely laterally; abdomen densely, rugosely punctured medially. Length 11.2 mm.; width 5.2 mm. (♀). Utah (Chadbourne's Ranch), — H. F. Wickham.....**proba** n. sp.

Form more slender, elongate-oval, polished, dark rufo-piceous throughout; head not closely punctured, very coarsely medially, less coarsely toward the sides and apex; prothorax transverse, nearly one-half wider than long, the apex fully three-fourths as wide as the base, subtruncate, being only just visibly though evenly sinuate, the angles right but only slightly blunt, not in the least anteriorly produced or prominent, the sides very feebly arcuate, becoming slightly sinuate apically and straight or subsinuate near the basal angles, which are right and not at all rounded; surface finely, very sparsely punctate medially, less finely and more closely apically, very coarsely but sparsely at about lateral fourth, except less coarsely and more closely at apex and in the basal impression and also densely near the sides; scutellum ogival, nearly as long as wide; elytra (♂) fully three-fourths longer than wide, gradually acutely ogival behind, the sides feebly arcuate, scarcely more rounding at base, the humeral callus strong, the punctures strong but sparse suturally, somewhat coarse but not much closer laterally, confused, the surface not impressed except feebly near the suture at apex; abdomen unusually coarsely punctate and not very rugose, the punctures close but somewhat separated medially. Length 10.0 mm.; width 4.3 mm. (♂). Utah (St. George), — H. F. Wickham.....**punctiventris** n. sp.

Form rather stout, larger, very convex, elongate-oval, highly polished, castaneous in color; head coarsely, rather sparsely punctured medially, less coarsely and rather closely anteriorly, the epistoma deflexed, moderate, rounded; prothorax somewhat less than one-half wider than long, moderately narrowed from the base, the sides feebly arcuate, becoming broadly and very slightly sinuate

near base and apex, the basal angles acute and somewhat everted, the apical obtuse and not prominent but not rounded, the apex distinctly and evenly sinuate; surface coarsely but sparsely punctate toward the middle, with a smooth line obliterated anteriorly, very coarsely, more closely so laterally but more finely toward the feeble basal impression near each side and also less coarsely, densely along the sides; elytra fully three times as long as the prothorax and nearly a third wider, rather rapidly ogival in about apical third, the sides arcuate, scarcely more strongly so toward the humeri, which are obtusely subangulate, rounded and slightly exposed basally, the callus long and distinct; surface without impressed lines, the punctures very coarse, rather sparse and confused throughout, smaller and closer near the sides; abdomen shining, coarsely, rather densely punctate medially, more sparsely on the first segment. Length 11.0–12.0 mm.; width 4.75–5.1 mm. Locality not recorded, but probably Utah,— H. F. Wickham.

perpolita n. sp.

4 — Elytra with distinctly though feebly impressed lines of aggregated coarser punctures. Body elongate-oval, convex, polished, pale brownish-testaceous in color throughout, with very small, sparse and decumbent fulvous hairs; head coarsely, sparsely punctate, more closely toward the eyes and anteriorly, the occiput, concealed by the prothorax, finely, closely punctured as usual, the epistoma broadly and obtusely triangular; prothorax not very transverse, about a third wider than long, the apex nearly four-fifths as wide as the base, evenly though very feebly sinuate, the angles slightly obtuse, not rounded but not at all prominent, the sides very feebly arcuate, becoming straight or subsinuate near apex and base, the basal angles right, not prominent, the surface with moderate and very sparse impressed punctures, becoming coarse and as a rule closer laterally and but little less coarse and very close near the sides; scutellum ogival, about as long as wide; elytra with rather strongly, evenly arcuate sides, gradually acutely ogival posteriorly, strongly impressed along the suture toward tip, coarsely, sparsely and confusedly punctured, the punctures but little coarser or closer but more uneven and with some fine punctures on the interstices laterally, the series throughout rather distinct; abdomen very finely, closely punctured and dull medially and with more evident pubescence throughout than on the upper surface. Length 10.3 mm.; width 4.2–4.65 mm. (♂ and ♀). Texas (near El Paso).

subseriata n. sp.

Elytra with broadly and feebly impressed lines, in which coarser punctures are aggregated even more closely and more conspicuously than in *subseriata*. Body much stouter and larger in size, blackish-castaneous, shining, strongly convex, broadly ovoidal; head coarsely and sparsely punctured, less coarsely and more closely toward the eyes and front but not at all densely, the epistomal lobe moderate, ogivally rounded; prothorax somewhat less than one-

half wider than long, moderately narrowed from the base, the sides feebly arcuate, becoming straight in basal fourth and near the apex, the basal angles acute and not at all blunt but not everted, the apical but little more than right, not rounded and not prominent, the apex evenly and distinctly sinuate; surface unevenly sculptured as usual, with a smooth subentire median line, the punctures rather coarse and very sparse centrally, closer near apex and base, becoming very coarse and close-set laterally, except that they are dense and less coarse near the base at each side and along the lateral margin; elytra distinctly more than three times as long as the prothorax and almost one-half wider, rapidly acutely ogival, with the sides less arcuate than usual, in about apical third, the sides arcuate, the humeri subangulate and slightly exposed basally, the callus elongate but moderate; surface widest rather behind the middle, sparsely and moderately punctate between the impressed lines of aggregated coarse punctures, the sculpture similar throughout the width; abdomen finely, densely punctate. Length 11.0 mm.; width 5.0 mm. Arizona (San Bernardino Ranch, Cochise Co.), — F. H. Snow.....**snowi** n. sp.

Elytra without impressed lines on the disk and with confused punctuation throughout 5

5 — Apical angles of the prothorax right or obtuse, not prominent...6

Apical angles acute, anteriorly prominent and somewhat everted...13

6 — Basal angles of the prothorax right, not at all rounded but neither everted nor prominent.....7

Basal angles strongly everted, acute and obliquely prominent.....12

7 — Head coarsely punctured.....8

Head finely and very sparsely punctured.....11

8 — Body more or less clear, though dark picco-testaceous in color throughout 9

Body piceous-black in color, small in size.....10

9 — Form rather narrowly elongate-oval, polished, subglabrous; head very sparsely punctured even toward the sides; prothorax about two-fifths wider than long, the apex fully three-fourths as wide as the base, evenly though very feebly sinuate, the angles slightly more than right, not at all rounded, not at all prominent, the sides feebly arcuate, straight near the apex and base, the surface unusually feebly convex, even, the basal impressions near the sides at the basal margin very short and extending along the basal sinuses, the punctures fine and very sparse throughout the length medially, becoming only moderately coarse but less sparse near lateral fifth and again small and close-set near the sides; scutellum evidently wider than long, ogival behind; elytra gradually narrowed posteriorly and narrowly rounded at tip, the sides feebly arcuate, gradually more rounded toward base, the humeri not exposed at base, with the callus small though pronounced, the impression within it feeble, the surface with the usual two or three feebly

impressed sutural lines toward tip, with moderately coarse, sparse and impressed punctures, becoming but little larger, only slightly less sparse and, as usual, more shallow and less impressed or more sharply defined laterally; abdomen with only moderately fine, dense punctures and minutely rugulose and but slightly shining medially. Length 10.3–10.4 mm.; width 4.2–4.3 mm. Western Arizona. [=*Epitragus pruinosus* Horn, — California (Owen's Valley)]..... **pruinosa** Horn

Form stouter, very convex, highly polished, darker in color and more properly deep rufo-piceous, the minute yellowish hairs inconspicuous; head moderately sparsely punctured, closely so laterally and apically; prothorax more transverse, very nearly one-half wider than long, the apex three-fourths as wide as the base, evenly though very feebly sinuate, the angles evidently more than right and somewhat blunt, the sides nearly as in *pruinosa*, the surface broadly convex, with the sublateral basal impressions very feeble though having notably less coarse, closer punctuation, the punctures only moderately small, strongly impressed and rather sparse, becoming very coarse, conspicuous and rather close-set near lateral sixth and again much smaller and dense very near the sides, the disk with an oblong irregular impunctate space at the middle of the length on each side near lateral fourth and another on the median line near the base; scutellum wider than long; elytra widest rather behind the middle, obese, somewhat rapidly acutely ogival behind, the sides feebly arcuate to the obtuse humeri, which are not much exposed, the callus moderate and elongate, the surface somewhat uneven, with the punctures rather coarse, very sparse, becoming still coarser but less sparse laterally; under surface polished as usual but with the entire abdomen strongly, moderately finely, very densely punctured and opaque. Length 11.0 mm.; width 4.8 mm. (♀). New Mexico (Deming), — H. F. Wickham.....**densiventris** n. sp.

Form very moderately stout, shining, the elytra alutaceous posteriorly, dark brownish-testaceous; head coarsely, sparsely punctured, less sparsely toward the eyes and front, the punctures impressed; prothorax two-fifths wider than long, the apex four-fifths as wide as the base, subtruncate, being only just visibly sinuate, the angles slightly obtuse but not at all rounded, the sides distinctly, subevenly arcuate, becoming straight only toward base, the surface not impressed but with smaller, though sparse, punctures toward base near lateral fifth, the punctures rather fine and very sparse throughout medially, becoming only moderately coarse but sparse laterally and less coarse, close though distinctly separated near the sides; scutellum moderate, wider than long, broadly ogival or angulate behind; elytra with feebly arcuate sides, gradually more arcuate and acutely ogival posteriorly, the humeri but little exposed at base, with the callus elongate and distinct, the punctures fine and very sparse, becoming only a little less fine and still sparse

laterally, the sutural impressions toward tip feeble; abdomen finely, closely punctate and opaque. Length 9.5 mm.; width 4.3 mm. Arizona (near Tuçson)..... .....**contaminans** n. sp.

10 — Body small, narrowly fusiform, strongly convex, polished, scarcely duller behind; head as in *contaminans* but with the deflexed tip of the epistoma more obtusely rounded and the sculpture less coarse; prothorax rather less than two-fifths wider than long, the apex barely three-fourths as wide as the base, evenly and feebly though distinctly sinuate, with the angles obtuse and blunt, the sides rather strongly arcuate at apical third, becoming more converging and straight thence to the apex, straight posteriorly to the basal angles; surface not impressed though with close and smaller punctures basally near the sides and with a pronounced fine groove along the basal margin, except medially, the punctures impressed, only moderately fine but sparse medially, becoming coarser and closer laterally and dense near the sides, the disk with a small impunctate area before the middle near each outer fourth and another on the median line near the base, somewhat as in *densiventris*, the scutellum and elytra nearly as in *contaminans*, the former larger, the latter more irregular in surface, with the punctures coarser and more widely impressed though almost as sparse, but little coarser or less sparse laterally, the humeri more rounded and not exposed at base; abdomen finely, densely punctate and opaque but with the second segment, in the unique type, more elevated than the others, less densely and more coarsely punctate and more shining, — probably an abnormality. Length 9.0 mm.; width 4.0 mm. Texas (El Paso).....**amplexa** n. sp.

11 — Form rather stout, oval, moderately convex, polished throughout, dark rufo-castaneous in color, the minute hairs inconspicuous; head with small, very remote punctures, becoming a little larger and less sparse in the intra-carinal depressions, rather close on the epistoma; prothorax transverse, one-half wider than long, the apex three-fourths as wide as the base, evenly and feebly but perceptibly sinuate, with the angles but little more than right and slightly blunt, the sides feebly, subevenly arcuate to the apical angles, becoming straight toward base, the punctures fine and very sparse medially, then, separated by a longitudinal impunctate area, becoming coarse and less sparse to the upper part of the shallow lateral declivity, on which the punctures are rather coarse and close-set; scutellum well developed, tumid, wider than long, broadly angulate behind; elytra slightly widest behind the middle, rather rapidly and acutely ogival, with the surface moderately declivous, behind, the sides broadly arcuate, a little more rounded basally, the humeri very narrowly exposed at base, with the callus strong, the surface even, coarsely, sparsely punctured, not more coarsely and but little less sparsely, the punctures more uneven in size with smaller punctures intermingled, laterally; abdomen only moderately finely, densely and strongly punctate and feebly shining. Length 11.0 mm.; width 4.75 mm. Arizona (Tuçson), — H. F. Wickham ....**sublæviceps** n. sp.

12 — Form stout, suboblong-oval, convex, shining, glabrous, dark brownish-testaceous in color; head coarsely, very regularly and rather closely punctured, the punctures separated by nearly twice their own diameters throughout though smaller anteriorly; prothorax nearly one-half wider than long, the apex fully three-fourths as wide as the base, evenly and very distinctly sinuate, the angles right, not blunt and very distinct, in fact subprominent, the sides feebly arcuate, becoming straight for a short distance anteriorly and broadly sinuate toward base, the basal angles broadly though feebly everted, acute and prominent, the punctures rather coarse and sparse, becoming very coarse but well separated laterally, except in the feeble basal impressions, where they are less coarse and closer and also on the flanks, where they are rather crowded; scutellum moderate; elytra parallel, with broadly and evenly arcuate sides to the base, gradually rather obtusely ogival posteriorly, the humeral callus long and strong, the surface broadly, strongly impressed at the suture near the apex, rather coarsely, sparsely punctate, almost similarly so laterally, except that the punctures become more perforate, less impressed and somewhat shallower; abdomen finely, very densely punctate and rather dull. Length 11.0 mm.; width 4.9 mm. Arizona (Cochise Co., — San Bernardino Ranch), — F. H. Snow..... **angulata** n. sp.

13 — Body elongate, fusiform, moderately stout, convex, the feebly fulvous hairs longer than usual and rather conspicuous though sparse, castaneous, the elytra paler and more testaceous; head not very coarsely and very unevenly punctured, very sparsely medially, closely anteriorly and toward the eyes; prothorax less transverse, only about a third wider than long, the apex fully three-fourths as wide as the base, evenly and very distinctly sinuate, with the angles somewhat acute, not blunt and decidedly prominent though not prolonged, the sides very feebly, evenly arcuate, scarcely becoming straight near the basal angles though distinctly sinuate behind the apical, the surface feebly, evenly convex transversely, finely, sparsely punctate, gradually coarsely and less sparsely so laterally, becoming less coarsely toward and in the scarcely visible basal impressions and smaller and crowded near the sides; scutellum moderate, nearly as long as wide, flat and ogival; elytra rather elongate, very gradually and arcuately narrowed and acute posteriorly, the sides broadly arcuate, but little more strongly so basally, where the humeral callus is strong and not much elongated, the surface distinctly impressed along the suture posteriorly, very finely, remotely punctured throughout, but little less sparsely toward the sides; abdomen moderately finely, densely but deeply punctate and dull, the basal segment, as usual, less densely, more coarsely so and more shining. Length 11.5 mm.; width 4.72 mm. California (southern).
californica n. sp.

The species resemble each other to superficial view very much,

but the sculpture of the abdomen is sufficiently diversified to afford recognizable specific characters, and this, with modifications in the form of the prothoracic apex and angles, general form of the body and sculpture of the upper surface, will probably lead to their identification with some careful study. I find that it conduces greatly to accuracy in identification, to have clean and well prepared specimens, mounted carefully, so that the axial plane of the body shall be horizontal. *Mctopoloba* is, in all probability, confined to the northern parts of the Sonoran faunal province, not extending far into Mexico.

Pechalius n. gen.

In its short and broadly oval form, marked pubescence and complete absence of supra-orbital carinæ, this genus would seem to be somewhat transitional between the genera that precede and *Epitragodes* and *Schœnicus*, which follow, but this appearance is in great part superficial, for in the produced prosternum, deeply received within an abrupt and profound mesosternal excavation and in the basally broadened form of the prothorax, it is undoubtedly a normal member of the *Lobometopon* group. The eyes are flattened and finely faceted, the mandibles squarely truncate at tip, with the apical smooth part abruptly delimited from the punctate basal part by a feebly impressed transverse line, the right with the usual dorsal tooth clasping the labrum. The upper line of the epipleuræ does not quite attain the sutural angles, ending at a very short distance therefrom in a feeble and scarcely noticeable thickening, the surface thence sloping rapidly to the angles. The tarsi show that the genus is really isolated and not related, as might be conjectured from the form of the elytral apices and the conspicuous vestiture, to the subgenus *Epitragoma* of *Lobometopon*, for here there is no trace of fine pubescence forming pads or otherwise distributed on any of the tarsi, all of which have the lower surface covered sparsely with short coarse spines. The type and only known species may be described as follows: —

Body broadly oval, very convex, black, polished, with a somewhat bright bronze lustre, the vestiture decumbent, rather long, consisting of arcuate whitish, somewhat matted hairs, forming obscure vittæ on the elytra; head rather coarsely and closely but unevenly

punctured, the epistoma broadly rounded, the lateral lobes small, strongly rounded; prothorax large, one-half wider than long, the apex barely two-thirds as wide as the base, transverse, with the angles gradually projecting anteriorly, prominent and acute but not blunt or narrowly prolonged, the sides almost straight and feebly converging from the right and unrounded basal angles for more than half the length, then broadly, rather strongly rounding and converging to the apical angles, the surface very obsoletely impressed near each side of the base, evenly and strongly convex, very finely and sparsely punctate, the punctures but little larger and still sparse laterally and more crowded along the sides; scutellum as long as wide, ogival, hairy; elytra rather abruptly and strongly, arcuately narrowed behind to the obtusely ogival tip, the sides parallel and broadly, evenly arcuate to the obtuse humeri, which are not evidently exposed at base and with the callus small but distinct, the surface smooth, without impressed lines even apically, very finely punctate, somewhat closely so laterally and in broad alternately closer and sparser longitudinal lines thence to the suture; abdomen more densely pubescent laterally, finely and strongly, rather closely punctate and shining medially. Length 9.4 mm.; width 4.4 mm. Texas (Marfa),—H. F. Wickham.....**subvittatus** n. sp.

I have before me but a single specimen of undetermined sex.

Epitragodes Csy.

This is one of the few Epitragid genera peculiar to the Caribbean faunal province. It is composed of moderate or small, oval and convex species, having coarse and conspicuous decumbent and irregularly disposed pale pubescence and the elytra gradually narrowed posteriorly to the notably acute apex. The genus is distinctly intermediate between the preceding genera, with a deep mesosternal excavation receiving the prosternum, and those which follow, having no prosternal projection or mesosternal impression, for here the prosternum is narrowly and briefly produced posteriorly behind the coxæ and the mesosternum is tumid and with a more or less feeble concavity, not however receiving the prosternum, which never attains the impression, these characters being plainly degradational or vestigial in nature. The mandibles are rapidly narrowed and polished toward their truncate apices, deeply excavated beneath toward base or strongly arcuate along the external line, and have the tooth of the right mandible, clasping the labrum, unusually developed, the left mandible tumid above and sometimes sub-

dentate. The eyes are well developed, more convex than in the preceding genus or *Lobometopon* and less finely faceted, though only moderately prominent and, as in *Pechalius*, without vestige of supra-orbital carinæ. The head is relatively smaller than in any of the preceding genera, with large, angulate or strongly ogival epistomal lobe, the prothorax narrowed and deeply sinuate at apex, with acute angles and also somewhat narrowed toward base, the elytral humeri being evidently exposed basally. The upper line of the epipleuræ attains the very acute sutural angles, becoming more posteriorly prominent than the lower margin, and the tarsi have dense pads of fine pale pubescence beneath, the posterior slender, with the fourth joint gradually thicker from base to apex, the claws strongly arcuate and stout. We have a number of species in our Floridian region as follows: —

Mesosternum rather deeply and very distinctly impressed.....2
Mesosternum equally tumid but with scarcely a vestige of impression..7
2 — Lateral lobes of the front very short, obtuse and inconspicuous...3
Lateral lobes slightly prominent and very narrowly rounded.....6
3 — Pronotum with feeble impressions at base near lateral fifth or sixth; femora minutely and sparsely punctate.....4
Pronotum without very evident basal impressions; size small; femora less finely but rather sparsely and strongly punctured.....5
4 — Body larger in size, elongate, fusoid, very acutely and gradually pointed behind, dark piceous, the legs and antennæ dark rufous, polished, the pubescence long, yellowish-white, sparse anteriorly, disposed in small condensed patches which are arranged linearly on the elytra; head sparsely punctate, very nearly as wide as the distance between the thoracic angles, which are acute and sharp but not prolonged; prothorax barely one-half wider than long, widest just before the middle, the sides rounded, converging anteriorly, feebly converging and nearly straight or feebly sinuate to the obtuse but not blunt basal angles, the apex deeply sinuate, barely three-fifths as wide as the base, the surface convex, finely, sparsely punctured medially, less finely, rather closely anteriorly, sparsely but rather coarsely laterally, the punctures attended by short carinæ near lateral fourth to sixth, then close and slightly rough to the sides, the basal impressions very small and adjacent to the hind margin; scutellum small, as long as wide, ogival behind; elytra two-thirds longer than wide, the sides broadly, evenly arcuate to the obtusely rounded humeri, which are evidently exposed basally, with the callus small and feeble, the punctures moderately large, close-set in even series which become

feebly impressed near the suture, the intervals with punctures of the same size very unevenly disposed, forming large areas of condensation and others which are wholly impunctate; abdomen sparsely pubescent, smooth, polished, minutely and sparsely punctured medially. Length 9.8 mm.; width 3.92 mm. (♂). Florida. [= *Epitragus tomentosus* Lec.,—Florida and Georgia].

tomentosus Lec.

Body nearly similar but much smaller, paler, rufo-piceous, the legs and antennæ pale brownish-rufous, polished, with a feeble æneous lustre on the elytra; head small, much narrower than the space between the thoracic angles; prothorax as in *tomentosus* but shorter, fully three-fourths wider than long, the apex nearly three-fourths as wide as the base, the punctures subeven in size and, on the whole, closer and much more conspicuous than in *tomentosus*, those near lateral fifth not definitely cariniferous, the basal impressions larger and extending some distance from the basal margin; scutellum similar; elytra relatively very elongate, almost similar in form, nearly four times as long as the prothorax, with the humeri more widely exposed at base, the sculpture similar but finer, the abdomen nearly similar. Length 7.8 mm.; width 3.4 mm. (♀). Florida (locality unrecorded).

debilicollis n. sp.

5 — Form rather stout, strongly convex, polished, scarcely with metallic lustre, very dark piceous, the tibiæ, tarsi and antennæ paler, rufous; pubescence white, disposed nearly as in *tomentosus;* head sparsely punctured, very nearly as wide as the space between the acute thoracic angles; prothorax unusually elongate, barely a third wider than long, in form nearly as in *tomentosus*, the surface with moderately small, very sparse impressed punctures medially, sensibly closer anteriorly, rather coarse, closer and strongly cariniferous near lateral fourth, then, separated by more or less impunctate spaces, less coarse though rather close, elongate and subcariniferous to the sides; scutellum slightly wider than long, rounded behind; elytra but little more than one-half longer than wide, widest slightly behind the middle, where they are not quite one-half wider than the prothorax, slightly more than three times as long as the latter, somewhat rapidly, acutely ogival behind, the sides broadly arcuate, the humeri obtuse, well exposed at base, the surface sculptured nearly as in *tomentosus* but with the series more or less interrupted and wholly unimpressed toward the suture, the intervals broadly impressed laterally; abdomen minutely, rather sparsely punctured medially, very smooth. Length 7.5 mm.; width 3.3 mm. (♂). Florida (Marion Co.).

pardalis n. sp.

Form nearly similar but less obese, paler, piceo-rufous, polished, the elytra with feeble cupreous lustre, the pubescence white, disposed nearly as in *pardalis* but with the condensed patches of the elytra smaller; head small, much narrower than the space between the

thoracic angles; prothorax more transverse than in *pardalis*, two-fifths wider than long, similar in general form but with the basal angles somewhat everted and more prominent, the surface similarly sculptured but with the median impunctate line narrower, more definite and entire, just visibly bi-impressed toward base; scutellum shorter, much wider than long, broadly ogival behind; elytra nearly similar but narrower and with the obtusely rounded humeri distinctly less exposed at base, the sculpture nearly similar but finer; abdomen finely though distinctly, rather sparsely punctured medially. Length 7.3 mm.; width 3.1 mm. (♂). Florida (Marion Co.)..... ....**cuprascens** n. sp.

6 — Form stout, convex, dark piceo-rufous in color, the legs not paler, shining but without much metallic lustre, the pubescence pale yellowish, disposed as in the preceding species; head rather sparsely but not very coarsely punctured, much narrower than the space between the thoracic angles; prothorax large, not quite one-half wider than long, formed nearly as in *tomentosus* but widest more posteriorly, somewhat behind the middle, the deeply sinuate apex two-thirds as wide as the base, the surface unimpressed, strongly convex, unusually punctured, the punctures large, impressed and rather close medially, becoming coarse, strongly cariniferous and dense laterally; scutellum wider than long; elytra but little more than three times as long as the prothorax and a third wider, gradually narrowed and very acute posteriorly, the humeri only moderately exposed at base, the sculpture nearly as in the preceding species but with the series toward the suture much more irregular, the first interval almost entirely punctate, especially so and closely, entirely obliterating the series, toward base; abdomen with the punctures not very fine, deep and very distinct, only moderately sparse medially, with the surface not smooth as usual but rugulose though shining; femora coarsely, deeply and very conspicuously punctured. Length 9.0 mm; width 3.9 mm. (♀). Florida (Lake Worth)...**floridanus** n. sp.

7 — Body stout, oblong-fusoid, rather abruptly narrowed but acutely pointed behind, dark rufo-piceous, the legs and antennæ scarcely paler, polished, the elytra with very feeble æneous lustre; pubescence white, disposed as usual; head small, with the lateral lobes of the front not prominent, much narrower than the space between the acute thoracic angles; prothorax larger than usual, one-half wider than long, formed as usual, widest at the middle, the surface evenly convex, not impressed, the punctures strongly impressed and sparse, becoming not much larger but closer though not dense laterally, sparsest near lateral fifth or sixth, the median impunctate line not extending to the apex; scutellum small, as long as wide, evenly ogival; elytra one-half longer than wide, barely three times as long as the prothorax, and, behind the middle, about a fourth wider, the sides feebly arcuate, the humeri very obtusely rounded and but little exposed at base, the

sculpture nearly as in *tomentosus* but with the series broadly and distinctly impressed toward the suture; abdomen feebly rugulose but shining, strongly, not very finely but sparsely punctured medially; femora moderately coarsely, sparsely punctured, the decumbent hairs borne by the punctures whiter, coarser and more conspicuous than usual; met-episterna finely punctured throughout. Length 8.4 mm.; width 3.9 mm. (♀). Florida (Capron). **obesulus** n. sp.

Body unusually narrow, strongly convex, dark piceo-rufous, the anterior parts more blackish as usual, the legs and antennæ not paler, polished, with the faintest opalescent lustre on the elytra; pubescence whitish, distributed as usual, the dense patches on the elytra very small, wanting near the suture; head nearly as in *obesulus*, distinctly narrower than the interangular space of the prothorax, the latter scarcely two-fifths wider than long, formed as in the preceding species, widest at the middle, the punctures small and sparse, denser near the apex, rather closer but not much larger and nearly simple laterally, with the usual less punctate regions near lateral fifth; scutellum small, as long as wide, ogival at tip; elytra three and one-half times as long as the prothorax and, near the middle, about a third wider, gradually acute posteriorly, the sides broadly arcuate, the humeri strongly rounding to the thoracic base and not much exposed basally; sculpture nearly as in *obesulus*, the punctures finer and the series toward the suture evidently impressed; abdomen smooth, finely, inconspicuously punctate; met-episterna punctured only in inner half; femora rather finely punctured. Length 7.0 mm.; width 3.1 mm. (♂ ?). Florida (Cedar Keys).....**macilentus** n. sp.

The sexual characters in this genus are very puzzling, judging from certain accidentally exposed portions of the œdeagus. In the male type of *pardalis*, for example, there is visible, projecting to the left from the crevice between the elytral tip and last ventral, a long and very slender process, not thicker than a hair, with its apex very briefly curved and falciform and extremely aciculate. On examining the insect from the rear, in the axial line of the body, the hair-like process seems to be the prolongation of a corneous piece, not unlike the ordinary pointed intromittent organ frequently protruded in the Epitragini and Eurymetoponini, except that here, instead of projecting in the axial line and curving upward, it lies transversely, with the hair-like appendage projecting to the left, as stated, when viewed from above. In the type of *cuprascens*, there is a similar hair-like process projecting likewise to the left, but shorter, with its apex strongly and abruptly curved and very acutely pointed or

spiniform, and its inner edge is occupied by a very thin flat fin-like semi-membranous keel throughout the length. I therefore regard the types of both of these species as male, and the differences in the size of the head, elongation of the prothorax and nature of the elytral sculpture will at once distinguish them, although they appear to come from nearly the same locality. The description and measurements of *cuprascens* are taken from the male alone, but the female, represented also by a single specimen, does not differ greatly, having the form a trifle stouter, the prothorax more transverse and the head relatively still smaller. The female sexual characters do not seem to be peculiar, as seen in the type of *floridanus*, the only one in which the female characters are exposed.

None of the three Central American species of *Schœnicus*, with posteriorly projecting prosternum, can apparently be included in this genus, as I at first supposed, and they will constitute one or two distinct genera, one of which has been named *Hemasodes* on page 378 of this revision.

Phegoneus n. gen.

In general facies this genus is very similar to *Lobometopon*, being evenly fusiform and moderately convex, but the prosternum is abruptly truncate at the hind margin of the coxæ and the mesosternum, although tumid between the coxæ, is wholly devoid of impression on its anterior declivity. It appears to replace *Schœnicus* in Mexico and Central America. The epistoma is produced in a large subangulate lobe, the lateral lobes almost undifferentiated, the mandibles as in *Lobometopon*, the right with a dorsal porrect tooth clasping the retractile labrum, the left without tooth, and they are gradually less punctate toward tip. The eyes are flattened and finely faceted, with very fine and feeble supra-orbital carinæ, the prothorax rounded at the sides, narrowed in front and frequently also toward base, with the apex more or less sinuate and the angles not very prominent, although generally not rounded. The scutellum is small and about as long as wide as a rule; the upper line of the epipleuræ attains the acute sutural angles and the elytra have well defined series of punctures. The anterior tarsi seem to have

tufts of very coarse and moderately dense hair beneath, in addition to the spinules, but the intermediate and posterior are certainly sparsely spinulose beneath and without finer pubescence of any kind. There are two species before me, which may be described as follows: —

Form moderately stout, elongate-oval, convex, glabrous, deep black throughout the body, legs and antennæ, the surface polished and with a deep greenish-metallic lustre; head small, much less than half as wide as the prothorax, rather coarsely, deeply and moderately closely punctate, more finely and densely toward apex and more finely but not densely toward base; prothorax about two-fifths wider than long, the apex barely three-fifths as wide as the base, with the angles obtuse and slightly blunt, the sides strongly arcuate, converging and less arcuate anteriorly, less converging basally, becoming very feebly sinuate just before the basal angles, which are right, somewhat prominent and not at all blunt; disk widest slightly behind the middle, evenly convex, coarsely, deeply and equally punctate throughout, densely toward the sides but a little more loosely medially, without evident impunctate line; scutellum rounded at apex; elytra gradually narrowed and acute behind, the sides evenly arcuate to the humeri, there becoming a little more strongly rounded to the thoracic base, the surface with unimpressed and even series of rather coarse and somewhat close-set punctures, becoming still coarser laterally, the intervals with smaller but deep and conspicuous punctures, confused or in irregular single series on alternating intervals; abdomen shining, strongly, somewhat sparsely punctured, coarsely toward the sides; basal joint of the hind tarsi much longer than the fourth. Length 9.5 mm.; width 3.8 mm. (♀). Texas. [= *Epitragodes jülichi* Csy.] ....**jülichi** Csy.

Form narrower, convex, elongate-oval, black throughout, somewhat shining, with strong dark bronze lustre above, brighter and more brassy beneath, glabrous; head a little more than half as wide as the prothorax, moderately coarsely, deeply, densely punctured throughout; prothorax two-fifths wider than long, widest at basal two-fifths, the apex two-thirds as wide as the base, very feebly sinuate, with the angles right and not blunt, the sides rather strongly arcuate posteriorly, converging and straight anteriorly, less converging to the basal angles, which are as in *jülichi*, the surface very evenly and only moderately convex and coarsely, deeply and equally punctured throughout, densely laterally and only a little less densely medially, with an occasional minute puncture intermingled as on the head; scutellum feebly angulate at apex; elytra three times as long as the prothorax, and, at the middle, about a third wider, very gradually and arcuately narrowed posteriorly to the acute apex, the individual apices very minutely, obliquely truncate, the sides evenly, moderately arcuate,

more strongly rounded at base to the prothorax, with series of rather coarse, close-set punctures, feebly impressed except laterally, the interstitial punctures but little smaller than those of the series, confused and closer toward base, sides and apex, sparser centrally; abdomen finely but strongly, sparsely punctured medially, coarsely toward the sides; basal joint of the hind tarsi equal in length to the fourth. Length 8.6 mm.; width 3.25 mm. Panama (Natá).....* **subæneus** n. sp.

The Mexican and Central American species described by Mr. Champion under the names *Schœnicus salvini*, *viridis*, *rufipes*, *impressus*, *chalybeus*, *difficilis*, *basalis* and *niger*, belong to the present genus and *subæneus* seems to be allied most closely to *salvini*, differing in the form of the prothorax, which is said to be widest at base in that species. The sides of the prothorax in this and the preceding genus are very finely, though evidently, margined, in marked contrast to the following two genera.

Schœnicus Lec.

This genus is a constituent of the Floridian province of the Caribbean faunal region, and is represented at present by a single rather rare species, of comparatively small size and slender form. It is distinguishable at once from *Phegoneus* by the exposed elytral humeri and large and very prominent, coarsely faceted eyes, without vestige of supra-orbital carinæ. The front of the head, epistoma, mandibles, mentum and antennæ are of the usual type in the preceding genera, but the prosternum between the coxæ is narrow and convexly declivous at the hind margin of the coxæ, and the mesosternum is not even tumid, though its surface before the middle coxæ is rapidly and strongly depressed far below the level of the intercoxal part of the mesosternum and metasternum. The anterior and, to a less degree, the middle tarsi, have conspicuous pads of fine dense pubescence beneath, but the posterior are simply spinose and the anterior and middle tibiæ are feebly prolonged and acute at the outer apical angle. The scutellum is moderately developed, as long as wide and strongly ogival; the upper line of the epipleuræ attains the very acute sutural angles. The type and only known species may be outlined as follows: —

Form elongate-suboval, convex, dark brownish-testaceous throughout, shining and without evident metallic lustre, sparsely covered with

short, fine, decumbent, yellowish and inconspicuous pubescence; head small, fully half as wide as the prothorax, slightly wider than long, rather finely and not densely punctate; prothorax small, two-fifths wider than long, the apex feebly sinuato-truncate and fully three-fourths as wide as the base, with the angles very obtuse and somewhat blunt; disk widest at the middle, where the sides are prominently rounded, thence strongly converging and straight apically and but little less converging and straight to the basal angles, which are more than right and very slightly blunt, the sides acute but not at all margined or reflexed; surface convex, feebly impressed on the basal lobe and midway between this and each side, rather finely, very sparsely punctate, becoming less finely but still not very closely laterally, with an impunctate line medially only toward base; elytra fully three-fourths longer than wide, three and one-half times as long as the prothorax, and, at the middle, nearly one-half wider, gradually and arcuately narrowed behind to the ogival apex, the sides broadly arcuate to the rounded humeri, which are transversely exposed at base; surface with one or two impressed lines along the suture, especially behind, finely, sparsely punctate and but little less finely or sparsely toward the sides, the punctures confused, with feebly defined and incomplete series of similar punctures here and there; abdomen finely, sparsely punctate even toward the sides, with similar very short, sparse and inconspicuous hairs. Length 7.5 mm.; width 2.9 mm. Florida (Tampa).....**puberulus** Lec.

The original unique type of *puberulus* was described from Georgia, and is said to have the elytra more than four times as long as the prothorax and with a faint metallic gloss; considering these differences, in connection with the inconspicuous pubescence of the Tampa representative, it is possible that there may be two distinct species involved. The sex of the specimen described above is not determinable.

Conœcus Horn.

In this genus the sides of the prothorax are completely devoid of beaded or reflexed edge, as in *Schœnicus*, the edge being obtusely rounded in section and punctate. The body is oval, the head, mandibles, mentum and antennæ as in *Schœnicus*, but the eyes are a little less developed and, though similarly coarsely faceted and without trace of supra-orbital carinæ, are much flatter and not at all prominent. The prosternum between the coxæ is convexly declivous behind them as in *Schœnicus*, but the intercoxal part of the mesosternum is tumid and its steep anterior slope is more or less deeply impressed as in *Epitragodes*.

The scutellum is small and flat; the upper line of the epipleuræ is obtuse, becoming altogether obliterated for a short distance beginning a little behind the humeri and it attains the very acute sutural angles. The body is more obese, with relatively larger prothorax, more broadly and less abruptly lobed at base than in *Schœnicus*, and the legs are shorter and stouter, the anterior tibiæ more strongly but obtusely prolonged at the external apical angle, the middle tibiæ simply feebly enlarged at apex. The tarsi are rather long, the last joint gradually, strongly enlarged from base to apex, the claws very stout, becoming strongly arcuate toward tip, straight toward base; the tufts of brilliant dense pubescence, clothing all the tarsi beneath, are composed of rather coarser hairs than in *Lobometopon* and some other related genera. This genus is very evidently a normal member of the tribe Epitragini and is wholly out of place among the Gnathosiini, to which it was assigned by its author. We have two species, which may be readily distinguished as follows: —

Form moderately stout, oval, convex, piceo-testaceous in color, still paler beneath, moderately shining, without metallic lustre, covered sparsely with short, decumbent, yellowish hairs, nearly as in *Schœnicus;* head small, less than half as wide as the prothorax, wider than long, coarsely, not very closely punctate, less coarsely, densely so anteriorly, with long and distinct oblique sutures, the epistomal lobe rather short, broadly angulate; prothorax large, nearly one-half wider than long, parallel, the sides more strongly converging toward apex, subevenly and strongly arcuate from the very obtuse but evident basal angles to the less obtuse but slightly blunt and not at all prominent apical angles, the apex feebly sinuate, three-fourths as wide as the base, the surface very evenly but rather feebly convex, not impressed, with moderate, deep, somewhat well separated punctures, becoming a little larger, perforate, elongate, close and tending to unite longitudinally laterally, and, again, very small along the lateral edges, also with an impunctate line obliterated anteriorly; scutellum ogival, as long as wide; elytra gradually and arcuately narrowed behind in almost apical half, the apex very acute, scarcely one-half longer than wide, two and one-half times as long as the prothorax and, before the middle, very slightly wider, the sides parallel, strongly, evenly arcuate to the obtuse humeral angles, which are scarcely at all exposed at base and with wholly obliterated callus, the surface with rather coarse, deep, sparse punctures, nearly equal though smaller near the sides than toward the suture, confused, but, in addition, with even series of slightly larger punctures along the central parts of each elytron; abdomen

coarsely, sparsely but conspicuously punctured. Length 6.2 mm.; width 2.7 mm. Texas..... ....**ovipennis** Horn

Form nearly similar though a little stouter and less parallel, darker, blackish-piceous, the legs pale rufous, shining, the elytra with feeble metallic lustre; pubescence nearly as in *ovipennis* but still shorter and less evident; head coarsely, rather closely perforato-punctate, with a small vertexal impunctate spot as in *ovipennis*, but with the punctures of the anterior part of the head coarser, more clearly perforate and more separated; prothorax twice as wide as the head, nearly as in *ovipennis* in form and sculpture; scutellum very small, rounded; elytra as in *ovipennis* but broader and, before the middle, fully a fifth wider than the prothorax, the humeri more transversely exposed at base and the punctures coarser, sparser and devoid of serial arrangement, fine along the elytral suture and scarcely so coarse at the sides as elsewhere; abdomen not very coarsely, sparsely punctate, very coarsely so on the first segment, this character being much more evident than in *ovipennis*. Length 6.6 mm.; width 2.92 mm. Texas.
estriatus n. sp.

These species are rather closely allied but the differences in color, sculpture of the anterior parts of the head, and of the entire elytra and basal part of the abdomen and relatively more inflated elytra, with more exposed humeral angles as detailed above, are so evident that there ought to be but little doubt in identifying them. The complete absence of the humeral callus distinguishes this genus from any other of the tribe in our fauna, and the general aspect, shorter elytra and more abbreviated metasternum, indicate a curtailment of the wings, a very exceptional character in the present tribe though probably occurring in *Tydeolus* also.

Tribe Triorophini.

The various genera of this tribe were assigned to a much more heterogeneous tribe Gnathosiini by Horn, but there are several characters pertaining to the American genera, such as general facies and sculpture, antennal structure and form of the scutellum, that indicate the very decided propriety of separating them as a distinct tribal group, having much more affinity with the purely North American Eurymetoponini, by way of the similarly geographically restricted Trimytini, than it has to the old world Gnathosiini, composed of such genera as *Gnathosia*, *Pachychila*, *Anatolica*, *Tentyria*, *Microdera* and many others.

The latter tribe, it is true, includes a notable diversity, especially of cephalic structure, but the genera have a certain community of habitus which renders them very distinct from our much smaller and more obscure forms. The general differential characters of this and related tribes are sufficiently set forth in the preceding table of tribes. The genera of Triorophini within our faunal limits are the following: —

Epistomal lobe parallel, very prominent, angulate at apex, clasped toward base by the swollen basal parts of the mandibles, the latter stout, each with a strong porrect dorsal tooth clasping the labrum, the right tooth the larger, their apex very unequally bifid, the lower lobe small, the upper larger and acute, becoming obtuse or truncate, their broad outer surface toward base not impressed; eyes transverse, emarginate anteriorly; prothorax margined at the sides; elytra inflated, with abbreviated series of coarse punctures, the epipleuræ narrow, equal throughout; legs long, the tarsi with sparse spinules beneath. [Type *T. lævis* Lec.] ..... **Triorophus**

Epistomal lobe shorter and wider, broadly angulate, clasped by the upper ridge of the mandibles when closed, the latter more feebly dentate above 2

2 — Epistomal lobe not deflexed 3

Epistomal lobe strongly deflexed, the line forming the upper margin of the deflexed portion continuous with the sides of the front when viewed from above; elytra oblong-oval, nearly as in *Triphalus* 8

3 — Tarsi spinose or with sparse spiniform hairs beneath, not pubescent; elytra strongly inflated, subglobose 4

Tarsi with long, coarse and dense, pale and conspicuous hairy vestiture beneath; body more cylindrical, the elytra less strongly inflated and more oblong-oval 7

4 — Eyes not emarginate anteriorly 5

Eyes more transverse, emarginated anteriorly by the lateral canthus ... 6

5 — Body glabrous, small in size; mandibles acutely bifid at tip, the lobes unequal, both acutely rounded; epipleuræ intruded upon and narrowed anteriorly by the met-episterna; elytra with more or less confused punctuation. [Type *Stibia ovipennis* Horn]. **Micromes**

Body strongly pubescent, small in size; mandibles broader and squarely truncate at tip; epipleuræ narrow but subequal in width throughout, the met-episterna narrow; elytra with strongly marked, regular and entire series of punctures. [Type *T. seriatus* n. sp.]. **Trichiotes**

6 — Body rather small, conspicuously pubescent; elytra with more or less confused punctuation; mandibles abruptly narrow beyond

the dorsal teeth as usual, the apex feebly, very unequally bifid, with the upper lobe broad and truncate, nearly as in *Triorophus* but with the outer side concave toward base; epipleuræ subequal in width throughout, the met-episterna rather wide. [Type *O. villosa* n. sp.]..... **Oxygonodera**

7 — Body larger than in the three preceding genera, subglabrous to sparsely pubescent, the elytra with even and entire series of conspicuous punctures; eyes emarginate anteriorly, not prominent; mandibles acutely and deeply bifid, the two lobes unequal, both acutely rounded, the outer surface concave at base only; elytra rather less inflexed beneath than usual, the epipleuræ broader, especially toward base, the met-episterna moderately narrow. [Type *T. perforatus* Lec.]..... **Triphalus**

8 — Form nearly as in *Triphalus*, the elytra with similar regular and entire series of coarse and conspicuous punctures; size relatively large as in *Triorophus;* tarsi pubescent and spinose beneath; eyes rounded, feebly emarginate anteriorly; mandibles without tooth on the upper surface — fide Horn. [Type *S. puncticollis* Horn]..... **Stibia**

In the structure of the front this tribe presents the same diversity as the Trimytini or the palæarctic Gnathosiini, comprising forms with prominent quadrate epistoma or a shorter and more triangular form of that part. The last five genera of the above table are related in this respect to *Triorophus*, in precisely the same way that the Mexican *Pescennius*, of Champion, is related to the other genera of the Trimytini, the only very important difference between these two tribes apparently being the strong inferior inflexion of the elytra in Triorophini and the absence of this character in the Trimytini; in the former, also, the prothorax is generally strongly narrowed to the base, while in the latter it is usually narrowed from the base forward, the chief exception being *Chilometopon*. The principal distinguishing character between the two tribes in question and the Eurymetoponini, which is also diversified to a considerable degree in the form of the front, is the fact that in the former the mandibles clasp or rest upon the epistomal lobe when closed, while in the latter tribe they slip entirely under the lobe, but in both cases they grasp and retract the labrum, either by a single tooth or by a tooth on each mandible, the latter being the usual condition in the Triorophini. The present tribe does not seem to include any of the Central American genera recently described by Champion, all of which may be readily assigned either to the Eurymetoponini or Trimytini.

Triorophus Lec.

In this genus the body is much larger than usual in the present tribe, elongate in form, with elongate-oval and strongly inflated hind body, the elytra in the normal species having rows of coarse punctures, becoming obsolete behind. The epistomal lobe is very prominent and is somewhat constricted at base, the bulbiform basal swelling of the mandibles fitting when closed into the reëntrant space at each side, and the surface behind the lobe is strongly swollen, forming a rounded prominence. The eyes are moderate, distinctly convex but not very prominent, and the lateral lobes of the front before them are strongly rounded anteriorly and externally, being, as a general rule, much more prominent than the eyes. There is a single long straight supra-orbital carina, supplemented generally by other shorter inner folds. The antennæ and legs are unusually long and moderately slender, the tarsi cylindric, in great part nude but with a few short stiff spines, more numerous beneath; basal joint of the posterior as long as the last or somewhat longer. The prothorax has an unusually distinct marginal bead at the sides, for in most of the related genera, this bead is in great part wanting, the edge being more or less acute in section but punctured and immarginate. At the apical angles there are several long vibrissæ similar to those noted in the Trimytini. The scutellum is small and transverse, not projecting posteriorly between the elytra, the latter strongly margined at base and with the epipleuræ narrow throughout; the met-episterna are also narrow and subparallel. *Triorophus* is a rather large genus, the species known to me being definable as follows: —

Surface glabrous or nearly so; elytra with regular, coarsely punctured series, obsolete toward tip. 2

Surface evidently pubescent or with the prothorax more coarsely and closely sculptured, the elytra at best faintly striato-punctate and sometimes with confused punctuation.....17

2 — Pronotum with a single system of punctures which are always well separated.....3

Pronotum with coarse punctures, mingled with others which are distinct but much smaller; integuments glabrous.....16

3 — Elytra strongly shining, sometimes alutaceous toward tip 4

Elytra entirely opaque; form very stout; each puncture bearing a very small hair..... 15

4 — Elytral series obsolete only slightly behind the middle.....5
Elytral series longer, obsolete only toward apex.....14
5 — Antennæ stouter, the tenth joint not or but slightly longer than wide.....6
Antennæ very slender, the tenth joint very much longer than wide...13
6 — Head not at all narrower than the prothorax. Body black, shining, the head sparsely punctate, with two supra-orbital folds at each side; prothorax punctate; elytra with rather large punctures, obsolete near the middle, arranged in nine series, the intervals and apex impunctate. Length 8.0 mm. California (Colorado Desert) .....**lævis** Lec.

Head evidently narrower than the prothorax in both sexes.....7
7 — Species of the California fauna. Body stout, strongly convex, very highly polished, black or with a feeble piceous tinge; head very obviously narrower than the prothorax, the frontal tumidity and the occipital region finely, sparsely punctate, the latter not rugose and unusually convex, with one or two acute plicæ near the orbital carinæ; antennæ stout, moderately long; prothorax large, between a fourth and third wider than long, the sides parallel and broadly rounded in about apical half, strongly converging and becoming broadly sinuate toward base, the latter truncate and very heavily beaded, fully four-fifths as wide as the apex, the latter very feebly sinuato-truncate, with the angles somewhat advanced and prominent, the punctures more or less fine and sparse, becoming rather coarse and deep but well separated laterally; elytra elongate-oval, the punctures coarse, arranged in series which are distinctly impressed, becoming obsolete at some distance behind the middle, the intervals with fine but unusually distinct, sparse and confused punctures obsolete toward apex; abdomen impunctate laterally, rather coarsely so toward the middle of the basal segment and distinctly, though finely, on the median parts of the second segment, the sterna and parapleuræ very coarsely but not closely punctate. Male with an elongate-oval, spongy-pubescent spot at the centre of the first ventral segment. Length 7.25–8.0 mm.; width 2.8–3.45 mm. California (Kern Co.) .....**politus** n. sp.

Species of the Arizona faunal regions.....8
8 — Elytra strongly shining throughout.....9
Elytra evidently alutaceous toward tip.....12
9 — Male with the pubescent fovea at the centre of the first ventral not impressed, elongate-oval in form.....10
Male with the pubescent fovea strongly impressed, more rounded...11
10 — Form rather stout, deep black, polished, glabrous; head finely, sparsely punctate posteriorly, sometimes feebly rugulose and with two or three sharp plicæ near the carinæ; prothorax a fourth to nearly a third wider than long, only moderately narrowed toward

base in basal half, the sides becoming straight and oblique, the apical angles rather prominent and thickened; surface very convex, finely, sparsely punctured, rather coarsely but still not very closely toward the sides; elytra rather short, distinctly less than one-half longer than wide, strongly arcuate at the sides, the serial punctures very coarse, the remainder of the surface finely and sparsely, confusedly and evidently punctate, obsoletely and very minutely toward tip. Length 7.0 mm.; width 2.8 mm. (♂ and ♀). Arizona (locality unrecorded)...**terebratulus** n. sp.

Form more elongate, similar otherwise, the head and prothorax of the male much larger than in the female, the former minutely, sparsely punctured, with the usual two to three acute rugæ near the carinæ; prothorax nearly similar but rather more transverse and more strongly narrowed basally, the sides generally becoming obviously sinuate toward base, the apical angles scarcely thickened and usually not at all prominent, a third to nearly two-fifths wider than long, the punctures almost as in *terebratulus* but finer throughout; elytra oval, more elongate, fully one-half longer than wide, with the immediate apex more prominently produced, the sides arcuate, the punctures of the series, the latter being similarly evidently impressed, much smaller and less conspicuous, the punctuation of the general surface excessively minute, almost wholly obsolete. Length 6.3–7.1 mm.; width 2.6–2.9 mm. (♂ and ♀). Arizona (Congress Junction), — F. H. Snow.
mundulus n. sp.

11 — Body nearly as in *mundulus* throughout, the head almost similar but with the punctures rather more distinct; prothorax nearly as in *terebratulus* and similarly punctate but rather more transverse, shorter in the female than in the male, the apical angles not thickened and not at all prominent; elytra slightly less than one-half longer than wide, oval, with the apex rather prominently produced, the feebly impressed series composed of deeply impressed punctures which are nearly as large and conspicuous as in *terebratulus* and much more so than in *mundulus*, the sparse punctures of the remainder of the surface very minute and only just visible, even toward base, wholly obsolete apically. Length 6.0–6.9 mm.; width 2.6–2.8 mm. (♂ and ♀). Arizona (Riverside), — H. F. Wickham.....**simplex** n. sp.

12 — Form stout, strongly convex, with very minute sparse hairs, deep black as usual; head finely, sparsely punctured and feebly, longitudinally rugulose, with the usual two or three acute folds near the carinæ; prothorax large, about a third wider than long, the sides rounded, converging only in about basal third, the apical angles thickened and evidently prominent, the punctures as in *terebratulus;* elytra short and broadly oval, less than one-half longer than wide, the series but just visibly impressed and composed of widely separated, moderately coarse punctures, smaller than in any of the three preceding species, the punctures of the

remainder of the surface sparse and extremely minute. Length 7.6 mm.; width 3.2 mm. (♀). Arizona.....**gravidulus** n. sp.

Form more elongate, similar in coloration, the very minute hairs even less obvious; head very much narrower than the prothorax, punctured finely and sparsely, with some feeble rugæ and acute juxtacarnal folds as in the preceding species; prothorax large, more transverse, nearly two-fifths wider than long, the sides unusually convergent in about basal half, becoming straight and oblique, with the basal angles formed by the basal bead as usual, the apical angles thickened and prominent, the punctures only moderately small and less sparse than in the preceding species, becoming coarse and separated by much less than their own widths laterally; elytra elongate-oval, fully one-half longer than wide, the base very strongly margined as usual but prolonged anteriorly beyond the arcuate part of the sides, suggesting a broad basal peduncle in a manner not noticeable in any of the preceding species, the punctures of the series only moderately coarse, those of the remainder of the surface minute but evident. Length 8.5 mm.; width 3.2 mm. (♀). Arizona (Riverside),—H. F. Wickham.....**basalis** n. sp.

Form nearly similar to *basalis* but smaller in size, similarly black and glabrous; head and general form almost exactly similar in the sexes, the former punctured and sometimes feebly rugulose as usual; prothorax about a third wider than long, the sides arcuately and moderately converging in about basal half, the apical angles thickened and somewhat prominent, the punctures sparser than in *basalis* and separated laterally by their own widths or more; elytra nearly as in *basalis* in form and sculpture but not produced anteriorly at base. Male with the densely fulvo-pubescent fovea of the basal segment of the abdomen feebly impressed and but little elongated. Length 7.2–7.4 mm.; width 2.8–2.9 mm. (♂ and ♀). Arizona (Benson),—G. W. Dunn.

histrio n. sp.

13 —Body rather stout, strongly convex, black and rather strongly shining throughout, glabrous; head much narrower than the prothorax, minutely, sparsely punctured and smooth, with a single strong acute plica near the carinæ; prothorax nearly two-fifths wider than long, rather strongly and arcuately narrowed behind from near apical third, the apical angles not at all thickened or prominent, the punctures only moderately small, impressed, sparse, becoming moderately coarse, impressed and separated by nearly twice their own widths laterally; elytra one-half longer than wide, oval, the very feebly impressed series composed of moderately coarse punctures, the remainder of the surface very sparsely and minutely punctate, scarcely distinctly so even toward base. Male with a nigro-pubescent abdominal fovea, much smaller than in any of the preceding species, not impressed and elongate-oval. Length 7.7 mm.; width 3.2 mm. (♂). California (San Diego).....**gracilicornis** n. sp.

Body more slender anteriorly, the hind body relatively more strongly inflated, as frequently the case in the female, rufo-piceous in color, shining throughout and glabrous; head finely, sparsely punctured, with about two juxta-carinal folds; prothorax formed nearly as in *gracilicornis* but arcuately narrowed behind only in about basal half, the apical angles not at all thickened or prominent, the punctures not very small and moderately sparse, impressed, becoming unusually coarse and separated by scarcely more than their own widths laterally; elytra more elongate-oval, more than one-half longer than wide, the scarcely at all impressed series composed of moderately coarse, deep punctures which are rather more close-set than usual, the interstitial punctures extremely minute and subobsolete even basally; basal segment of the abdomen even more coarsely and plentifully punctate medially than usual. Length 7.5 mm.; width 3.2 mm. (♀). Arizona.
longicornis n. sp.

14 — Form elongate, convex, shining, the elytra somewhat alutaceous, black, the under surface, legs, head and prothorax more or less rufo-piceous; minute hairs frequently distinct; head rather coarsely and longitudinally, subconfluently punctate, forming rugæ, those near the strong orbital carinæ not more pronounced than the others; antennæ rather long and slender, the tenth joint longer than wide; prothorax a little wider than the head, more distinctly in the female, almost one-half wider than long, moderately and arcuately narrowed behind in rather more than basal half, the apical angles not thickened or prominent, the punctures rather coarse, deep, well separated medially but still coarser, elongate and separated by their own widths but tending to longitudinal coalescence laterally; elytra very elongate-oval, much less inflated than usual, three-fifths longer than wide, the very feebly impressed series composed of moderately coarse, unusually close-set punctures and distinct to within a short distance of the apex, the inner series curving outwardly toward base, where there is sometimes a short post-scutellar series; interstitial punctures small and sparse, confused, sometimes very distinct; abdomen, contrary to the general rule, evenly and rather sparsely but strongly punctured throughout, the pubescent fovea of the first segment (♂) not impressed and moderate in size. Length 6.4–7.3 mm.; width 2.7–2.85 mm. (♂ and ♀). California (Tulare Co.)...**rugiceps** Lec.

Form very stout, large in size, deep black, shining and glabrous throughout, the legs rufo-piceous and the elytra feebly alutaceous posteriorly; head slightly narrower than the prothorax, the anterior tumidity large, strong and punctured as usual, the basal parts convex, very finely, sparsely punctured and smooth, with about two folds near the carinæ; antennæ rather long and slender, the tenth joint slightly elongate; prothorax large, not quite one-half wider than long, inflated at the middle, thence rather strongly narrowed, with the sides becoming sinuate to the base, the an-

terior angles thickened and decidedly prominent, the punctures moderately small and well separated, deep, becoming rather coarse and separated by barely their own widths laterally; elytra strongly inflated, oval, two-fifths longer than wide, with scarcely impressed series of very coarse, deep, moderately close-set punctures, disappearing at about apical fourth, the interstitial punctures minute, sparse and inconspicuous; abdomen minutely, sparsely punctured, the basal segment becoming coarsely punctured only near the coxæ. Length 8.5 mm.; width 3.75 mm. (♀). Texas.
lecontei Csy.

15 — Body very stout, deep black, the legs rufo-piceous, the anterior parts alutaceous, the entire elytra deeply opaque, head much narrower than the prothorax, smooth, minutely, sparsely punctate, with very fine and feeble rugæ near the carinæ, the umbo very large and conspicuous; antennæ moderate, the tenth joint fully as wide as long; prothorax transverse, fully three-fifths wider than long, the sides rounded, becoming strongly convergent and sinuate in only about basal third, the apical angles thickened and very prominent, the punctures fine and moderately separated, becoming moderately coarse and separated by scarcely more than their own widths laterally; elytra very inflated and convex, barely a fourth longer than wide, the unimpressed series composed of moderately coarse, deep and rather widely spaced punctures, continuing to apical fourth or fifth; abdomen dull, minutely, sparsely punctate, the first segment coarsely punctured medially along each side of the median line, except toward apex. Length 7.8 mm.; width 3.6 mm. (♀). Texas ....**nodiceps** Lec.

16 — Form stout, convex, deep black, the legs and antennæ more or less rufo-piceous, almost glabrous, each puncture with a minute hair, feebly alutaceous, the entire elytra with dull lustre; head smooth, minutely, sparsely punctate, with the umbo large and prominent, the surface without plicæ near the strong orbital carinæ; prothorax much wider than the head, transverse, three-fifths wider than long, the sides inflated, strongly and arcuately converging in basal half, becoming sinuate basally, the anterior angles thickened, acute and very prominent; surface widest at the middle, strongly, closely punctate, very coarsely and more closely so laterally, the punctures mingled everywhere with smaller distinct punctures, rendering the sculpture rather dense throughout; elytra strongly inflated and convex, oval, about two-fifths longer than wide, with unimpressed series of only moderately coarse, widely separated punctures, becoming gradually smaller and disappearing between apical third and fourth, the sparse interstitial punctures extremely minute and scarcely visible; abdomen finely, sparsely punctured, with some coarse punctures on the first segment, where the fusco-pubescent male fovea is unusually small, unimpressed and elongate-oval. Length 6.7 mm.; width 3.25 mm. (♂). Texas (Laredo), — H. F. Wickham.
brevis n. sp.

Form nearly similar but with more inflated elytra and shining, the surface only feebly alutaceous posteriorly, glabrous, very deep black, the legs and antennæ feebly rufo-piceous; head relatively larger, less distinctly narrower than the prothorax, with less elevated umbo and less minute but sparse punctuation, the surface not so smooth and with a single short plica near the carinæ; tenth antennal joint somewhat more elongate, obviously longer than wide; prothorax larger, much less transverse, not quite a third wider than long, less inflated at the sides, the latter parallel and broadly arcuate, becoming moderately strongly convergent and feebly arcuate in about basal half, sinuate very near the angles, the apical angles thickened and prominent though less so than in *brevis*, the punctures very uneven, generally rather well separated medially but becoming closer laterally and composed of coarse and moderately small punctures intermingled; elytra more elongate-oval though scarcely one-half longer than wide, with very feebly impressed series of unusually coarse, deep and less widely spaced punctures, gradually becoming obsolete only at apical fourth or fifth, the lateral series approaching the apex still closer as in *brevis;* abdomen shining, finely, sparsely punctured, the basal segment (♂) having a moderately large, circular and unimpressed fulvo-pubescent fovea, surrounded for some distance on all sides by minute and close-set punctures, this feature being much more obvious than in *brevis*. Length 7.5 mm.; width 3.5 mm. (♂). Texas (El Paso), — G. W. Dunn.
mixtus n. sp.

17 — Color brownish-black, paler beneath, subopaque; head coarsely and densely punctured and longitudinally finely sulcate, the umbo moderately prominent, finely punctured; prothorax slightly broader than long, the sides moderately rounded, the surface convex, coarsely and densely but not confluently punctured, the head and pronotum with sparsely placed short yellow hairs; elytra oval, moderately convex, faintly striato-punctate, the interstices having two rows of very faint punctures, sparsely pubescent, with the short hairs arranged between the rows of larger punctures; prosternum and side-pieces coarsely and densely punctured, the meso- and metasterna very coarsely so, the abdomen finely and sparsely. Length 7.5 mm. Locality not stated.
subpubescens Horn

Color piceous, the form stout; head narrower than the prothorax, aciculate and coarsely punctured, the umbo moderate; prothorax transverse, coarsely and confluently punctate and rugose; elytra rather closely, less finely punctate than usual, but with the punctures scarcely forming series. Length 6.25 mm. California (Vallecito, — near Julian?) ....**punctatus** Lec.

The species from *lævis* to *histrio*, in the table, are rather closely allied among themselves and are geologically recent

derivatives of a common stem form, though undoubtedly distinct; *levis* is defined above from the original diagnosis and is a larger species, with larger head, than any of the allied Arizonian forms; it is confined to the Colorado Desert, from which region I have no material at present. The locality given by LeConte for *rugiceps* is San José, which is certainly a mistake, Tejon being probably intended; it is a widely isolated species, not at all closely allied to any other, if I have properly identified it, constituting a type apart from the others in general form and details of sculpture. I have been forced also to define *subpubescens* and *punctatus* from the original descriptions of LeConte and Horn; they seem to differ very much from the others in pronotal sculpture, and especially in the punctuation of the elytra, and may have to be separated subgenerically; at present they are represented by uniques as far as known to me.

Micromes n. gen.

With this genus begins a series of very small forms, differing radically from *Triorophus* in having the epistomal lobe short, broadly angulate and less fully clasped by the mandibles, the latter being nearly similar in structure but without the bulbose swelling at base and less strongly, though somewhat similarly, toothed above, the left very feebly as usual. They also differ in having the side margins of the prothorax narrowly convex in section but not accentuated by a bead, reflexed or otherwise, being continuously punctured from the upper to the under surface. In the present genus the eyes are variably prominent, coarsely faceted but not anteriorly emarginate, and there is no trace of a supra-orbital carina. The antennæ are slender, moderate in length and of the same general structure as in *Triorophus*, but the met-episterna are wider and intrude somewhat upon the narrow epipleuræ, reducing the width of the latter anteriorly still further. The male sexual characters are precisely as in *Triorophus*, the basal segment of the abdomen having a large central, densely pubescent depression or fovea. The type of *Micromes* was described by Dr. Horn as a *Stibia*, but it is evidently not very closely related to that genus, as shown by general form of the body, type of elytral sculpture and form

of the epistoma. The genus is apparently very restricted in habitat, neither of the species now known occurring far from San Diego in California; the two represented in my cabinet may be defined as follows:—

Form stout, suboval, convex, polished, glabrous, black or piceous-black, rather paler beneath, the legs and antennæ rufo-piceous; head rather small, much narrower than the prothorax, strongly, moderately coarsely and not very densely punctate, the punctures tending to coalesce longitudinally; eyes rather small, extremely convex and prominent; prothorax transverse, not quite twice as wide as long, parallel, widest at the middle, the sides evenly arcuate, the apex broadly sinuate, with the angles scarcely less than right, not rounded but not prominent, the basal angles obtuse though scarcely rounded, the surface strongly convex, deeply, closely punctate, the punctures elongate, small and not dense medially but coarser, dense and somewhat longitudinally coalescent laterally; scutellum small, transverse, extending but little behind the elevated basal margin of the elytra, the latter oval, inflated, about a fourth longer than wide, the sides more strongly rounding toward base, more than three times as long as the prothorax and, at the middle, fully three-fourths wider, not very coarsely or deeply, sparsely punctate, the punctures arranged in feebly defined series, with confusedly and almost equally strongly punctate intervals, the punctures obsolete in about apical fourth; abdomen smooth, almost impunctate except the basal segment, the latter (♂) with a large and somewhat oval central pubescent fovea. Length 3.2–4.1 mm.; width 1.7–2.2 mm. California (San Diego). [= *Stibia ovipennis* Horn].

ovipennis Horn

Form less stout, convex, shining, glabrous, pale piceo-testaceous in color; head small, rounded, rather finely, closely strigilato-punctate, the eyes larger than in *ovipennis* and much less convex, although prominent; prothorax almost similar in form but relatively somewhat smaller and less transverse, more finely, not very densely strigilato-punctate, but little more coarsely so laterally and subevenly throughout; scutellum similar; elytra more elongate-oval, a third longer than wide, about two-thirds wider than the prothorax, sparsely and not coarsely, shallowly punctate, the punctures arranged in unimpressed series, obsolete in about apical two-fifths, the intervals similarly and uniseriately punctate; abdomen very minutely, sparsely punctate, the basal segment (♂) with a large oval pale-pubescent fovea; basal joint of the anterior tarsi shorter than in *ovipennis* and much shorter than the next two combined, the legs more slender. Length 3.2–3.8 mm.; width 1.4–1.8 mm. California (San Diego). [= *Stibia maritima* Csy.] ..... **maritimus** Csy.

The differences between these two species in the eyes and

relative lengths of the anterior tarsal joints are almost subgeneric. *Maritimus* appears to be much rarer than *ovipennis*, which is rather abundant. The male is distinctly less obese than the female and usually much smaller in size.

Trichiotes n. gen.

With mandibles and epistomal lobe formed as in *Micromes*, the present genus reproduces *Triorophus* in general form and sculpture, but differs from either in being clothed sparsely with very long erect and conspicuous setiform pubescence. The head is nearly as in *Triorophus*, excepting the front and mandibles, the rather prominent and coarsely faceted eyes being bounded above by a short and rather feeble carina; they are transversely oval and are not more than feebly impressed anteriorly by the canthus of the front. The antennæ and legs are rather short and stout, the tarsi notably short, the met-episterna narrow, not intruding upon the epipleuræ, which are narrow though equally wide throughout as in *Triorophus*, and the elytra, similarly, have regular series of coarse punctures. The form of the prothorax is almost exactly as in *Triorophus*, but the flanks are subevenly convex and without trace of beaded or reflexed side-margin, being very obtuse in section. The single species may be described as follows: —

Form rather stout, very strongly convex, shining, clothed throughout with very long erect yellowish-cinereous hairs, not concealing the integuments, serial in arrangement on the elytra and arising from the interstitial punctures, black, the under surface, legs and antennæ more or less paler piceo-rufous; head evidently narrower than the prothorax, rather wider than long, coarsely, somewhat closely and, toward the sides, more or less confluently punctato-rugose; prothorax nearly one-half wider than long, parallel, with the sides broadly arcuate anteriorly, becoming strongly and arcuately narrowed in about basal half, the sides sinuate before the acute and minutely prominent basal angles, the apex broadly sinuate, with the angles acute, slightly everted and prominent though not produced; surface very strongly, evenly convex, very coarsely and closely but not confluently punctate; scutellum small, transverse, forming part of the strongly elevated basal margin of the elytra as usual in this tribe; elytra strongly inflated and convex, oval, about a fifth longer than wide, scarcely three times as long as the prothorax and, at the middle, fully two-thirds wider, having each nine regular and broadly impressed entire series of coarse,

perforate, rather close-set punctures, becoming only slightly smaller toward tip, the intervals each with a very uneven series of small setigerous punctures; abdomen shining, rather coarsely but not strongly, moderately closely punctate, the first and second segments in the unique type each with a feeble ridge at each side, curving from the anterior edge posteriorly and inwardly toward the hind margin of the segments. Length 4.8 mm.; width 2.5 mm. Texas (Big Springs), — H. F. Wickham...**seriatus** n. sp.

The general form of this species suggests some of the Otiorhynchid genera allied to *Mylacus* and *Sciopithes*. It is impossible to state whether the singular obliquely curved ridges at the sides of the abdomen are sexual or not; there is no trace of a pubescent fovea at the centre of the first segment in the type specimen.

Oxygonodera n. gen.

This genus is also characterized by its conspicuous vestiture of long erect setiform hairs, but the facies is less like that of *Triorophus*. The head is nearly as in *Trichiotes*, the frontal parts being similar, except that the mandibles are stouter and more deeply concave externally toward base, but the antennæ are more slender, with a relatively greater development of the last two joints and the transversely oval, coarsely faceted and moderately prominent eyes are decidedly emarginated by the lateral canthus of the front; the supra-orbital carina is small and inconspicuous though present. The prothorax is, in general terms, transversely parallelogrammic, having a very great development of the anterior angles, which are prolonged as in *Edrotes*, and the sides, though acute in section, are not margined but punctured like the rest of the surface as in the two preceding genera, the scutellum and raised basal margin of the elytra being also similar; the elytral punctuation is even more confused than in *Micromes*, with the narrow epipleuræ as in *Triorophus*, the met-episterna wider as in *Micromes*, but not reducing the width of the epipleuræ. The legs and tarsi are rather short and stout.

A species congeneric with the type of this genus was assigned to *Stibia* by its author, but of course provisionally, as there is but little resemblance between the two genera. *Oxygonodera* is a localized type, like the two preceding, and is peculiar to

the arid regions of the great basin of Utah and perhaps eastern Nevada; the three species may be outlined as follows:—

Base of the prothorax slightly wider than the apex. Form robust, piceous-black, moderately shining, sparsely clothed with moderately long yellowish hairs; head coarsely, densely and substrigosely punctured, the epistomal lobe rounded in front; prothorax twice as wide as long, the apical angles acute and very prominent anteriorly, the base slightly arcuate at the middle, feebly sinuate laterally, the hind angles right, the sides very feebly arcuate; surface very convex, with an ante-basal transverse impression, coarsely, deeply and rather densely punctured, becoming somewhat strigosely so laterally; elytra broadly oval, very convex, moderately coarsely but not densely punctured, the punctures with faint tendency to serial arrangement; prothorax beneath very coarsely, deeply and rather densely punctured, the mesosternum less coarsely so, the metasternum with very large deep punctures; abdomen moderately densely punctured; outer margin of the anterior tibiæ slightly spinulose. Length 5.5 mm. Utah. [=*Stibia hispidula* Horn].....**hispidula** Horn

Base of the prothorax slightly narrower than the apex; erect vestiture very long.....2

2 — Body moderately stout, very convex, somewhat piceous-black, the legs and antennæ more rufous, strongly shining, sparsely clothed with very long sparse fulvous hairs; head moderate, wider than long, much narrower than the prothorax; coarsely but not very densely punctate, the punctures elongate and somewhat longitudinally coalescent; epistoma strongly angulate; prothorax not quite twice as wide as long, widest somewhat before the middle, the sides subparallel and feebly, subevenly arcuate, sinuate at the acute and prominent basal angles and feebly subsinuate toward the anteriorly produced and acute apical angles, the apex between the angles transversely truncate, the base very broadly, feebly lobed, without beaded edge, the surface very convex, strongly and transversely impressed before the basal lobe, coarsely, deeply and closely punctured, the punctures elongate and irregularly longitudinally subconfluent, coarser and more anastomosing toward the sides; elytra oblong-oval, moderately inflated, very convex, a fourth longer than wide, between three and four times as long as the prothorax and two-fifths wider at the middle, coarsely, deeply, not very closely and confusedly punctured throughout, rather less coarsely so toward tip; abdomen coarsely, deeply and closely but not confluently punctured throughout. Male with a moderate circular pubescent fovea at the centre of the first ventral segment. Length 4.8–5.2 mm.; width 2.3–2.6 mm. (♂ and ♀). Utah (Marysvale), — H. F. Wickham.....**villosa** n. sp.

Body very stout and convex, oblong-oval, deep black, with dark rufous legs and antennæ, highly polished, the very long and sparse

erect hairs fine and yellowish-cinereous in color; head large, wider than long, narrower than the prothorax, coarsely but not very closely, unevenly punctate, densely and with anastomosing rugæ laterally, the epistoma triangular, with parabolically rounded apex; prothorax more transverse, twice as wide as long, widest toward apex, the base as in *villosa* but more distinctly narrower than the apex, the sides very feebly arcuate; basal angles right, not prominent, the apical perhaps a little less produced and thicker than in *villosa* but very prominent, the remaining characters as in that species, except that the surface between the subbasal impression and basal margin is subimpunctate; elytra nearly similar but broader, barely three times as long as the prothorax and about a fourth wider, still more coarsely, confusedly and equally sparsely punctate; abdomen more coarsely, densely and subconfluently punctate, the male sexual characters similar. Length 5.6 mm.; width 2.8 mm. (♂). Utah (Clear Lake), — H. F. Wickham.....**grandiceps** n. sp.

I do not have an example of *hispidula* before me at present, the above description being by Dr. Horn, but if the language is correct it is distinct from either of the others, notably in its basally broader prothorax, more rounded epistoma and apparently less elongate vestiture. There are probably a number of species still to be discovered but they are individually rare.

The flanks of the elytra have a large deep indentation near basal third in this genus, which remarkable character is phylogenetically the same as the short furrow noted so frequently in the Eurymetoponini.

Triphalus Lec.

The body in this genus is still less inflated posteriorly and more cylindrical than in *Oxygonodera*, and we return to the margined sides of the prothorax characterizing *Triorophus*, but there are some features which indicate a departure in the direction of the Trimytini; the elytra, for example, embrace the sides of the body less widely than in any of the preceding genera and the male has no pubescent fovea on the first ventral. In most of its characters and in general facies, however, it is wholly isolated, the head as in the preceding genus but with the eyes less prominent and in fact but feebly convex, coarsely faceted, well developed and anteriorly emarginate and bounded above by a very fine and feeble carina, the antennæ long in the type species, with the three outer joints larger as in *Triorophus*. The

epistomal lobe is triangular and its sides are obtusely pectinate, somewhat as in the subgenus *Pimalius* of the Trimytini, although there the lobe is approximately semicircular. The prothorax is of peculiar cylindric form, rectilinearly truncate from side to side anteriorly and very broadly and feebly lobed at base, none of the angles being in the least prominent although not rounded. The elytra have the elevated basal margin and scutellum of the preceding genera, but the epipleuræ are narrow posteriorly, becoming gradually rather wide toward base, the met-episterna moderately narrow, becoming broader anteriorly, the legs rather short and stout, strongly punctate, the tibiæ with two external carinæ separated by a longitudinal groove, and the rather short thick tarsi are densely pubescent, the basal joint of the posterior less elongate than usual and somewhat shorter than the fourth. The genus is peculiar to the warm southern part of the peninsula of Lower California, the two species thus far known being definable as follows:—

Form elongate-subcylindric, the hind body moderately inflated, brownish-testaceous in color throughout, alutaceous in lustre, glabrous, each puncture with a very small and scarcely visible hair entirely within its limits; head coarsely, densely and subconfluently punctate, the antennæ slender, rather longer than the head and prothorax, the latter a fourth wider than long, with the base just visibly wider than the apex, the sides nearly straight, the sides and base beaded, the apical angles right, the basal slightly obtuse; surface cylindrically convex, very coarsely and subconfluently punctate, scarcely more coarsely so laterally; scutellum well developed, transverse, forming part of the raised elytral base; elytra nearly one-half longer than wide, oblong-oval, less than three times as long as the prothorax and, at the middle, about one-half wider, with nine discal, apically impressed, entire and regular series of very coarse, perforate and rather widely spaced punctures; abdomen coarsely and very deeply but somewhat sparsely punctate. Length 7.0 mm.; width 3.12 mm. Lower California.
perforatus Lec.

Form rather more slender, smaller in size, the hind body more abruptly but not more strongly inflated, piceous-black, the legs and antennæ dark rufous; surface rather shining and with distinct but sparse vestiture of short, suberect, somewhat coarse fulvous hairs; head coarsely, very densely punctato-strigose throughout, the antennæ much shorter, not as long as the head and prothorax, the latter more than a fourth wider than long, distinctly wider than the head, with the apex and base equal in

width, widest before the middle, the sides feebly but evidently arcuate, becoming straight or subsinuate toward base, the basal and apical angles both rather more than right, the remaining features almost as in *perforatus*, the punctures, however, even coarser, denser and more coalescent medially, becoming slightly less coarse laterally; scutellum smaller and more projecting and rounded behind; elytra one-half longer than wide, very nearly three times as long as the prothorax and one-half wider, with regular and entire series, which are impressed throughout but more strongly toward apex, of very coarse, perforate, less widely spaced punctures; abdomen very coarsely and deeply but not densely punctate. Length 5.5 mm.; width 2.42 mm. Lower California (San José del Cabo).....**cribricollis** Horn

The unique type of *cribricollis* was described (Proc. Cal. Acad. Sci., V, 1895, p. 251) from Miraflores, but does not seem to differ from the San José specimens, one of which was kindly given me by Mr. Chas. Fuchs, except in the apparently more densely punctate head, and in that the very small sparse punctures of the elytral intervals are scarcely arranged in double series but evidently more confused.

Stibia Horn.

The only marked difference between this genus and *Triphalus* resides in the abruptly deflexed epistomal lobe, but if the mandibles are really without a dorsal tooth, as stated in the original description, it would depart radically, not only from *Triphalus* but from every other genus of the tribe, so that I am disposed to regard this statement as due to an error of observation. The general form and sculpture of the body, eyes and superciliary ridge are nearly as in *Triphalus*. The only species which can enter the genus at present, is one of the largest of the tribe, greatly surpassing *Triphalus* and equaling the largest known forms of *Triorophus;* it may be described as follows:—

Form elongate, black, the legs ferruginous-brown, shining; head coarsely and confluently punctured; prothorax moderately convex, coarsely and densely punctured, one-half wider than long, the sides broadly rounded, with the margin acute, the angles distinct but not prominent, the apex feebly emarginate, the base feebly lobed; elytra convex, elongate, oblong-oval, with nine discal series of strong punctures, one marginal series and a short scutellar row of a few punctures; under surface coarsely and densely punctured. Length 8.0–9.5 mm. Lower California.
puncticollis Horn

The original specimens were taken by Mr. Gabb, and the only one in the collections reported upon by Dr. Horn (Proc. Cal. Acad. Sci., IV, 1894) from San José del Cabo, is said to be somewhat aberrant, having the prothorax less narrowed behind and the striæ better marked, with coarser punctures. The prothorax therefore seems to be narrowed toward base in *puncticollis*, although this is not directly stated by the describer.

Tribe Edrotini.

This tribe, through the Erodiini, connects the preceding tribes with the remarkably divergent Adesmiini and Craniotini. The prominent unemarginate eyes and very acute and anteriorly prolonged thoracic angles, constituting such marked features, were presaged in *Micromes* or *Trichiotes* and *Oxygonodera* of the Triorophini but, because of its peculiar habitus and structure, there can nevertheless be no question of its profound isolation. *Epiphysa*, although placed tribally with *Edrotes* by Lacordaire, seems to differ so greatly in the structure and degree of separation of the hind coxæ and form and vestiture of the tarsi, as well as in general facies and geographic distribution, as to require a tribal group by itself, and indeed that author himself placed the two genera in different subtribal groups of his "Epiphysides" or Epiphysini. The tribe Edrotini is confined to the Sonoran regions of North America and, so far as known, is represented only by the two following genera: —

Body rounded, convex, with sparse conspicuous erect hairs, the head large, the epistomal lobe quadrate, with its sides parallel and sinuate and apex broadly angulate nearly as in *Triorophus*, clasped by a basally somewhat bulbose, thin dorsal ridge of the mandibles, the latter stout, convex, with the internal dorsal ridge terminating on each in a porrect acute tooth clasping and retracting the labrum, the apex obtusely and unequally bifid and impressed for some distance behind the shallow incisure; mentum transversely hexagonal, the apex trisinuate, the median sinus smallest and most angular; eyes small, very convex and prominent, moderately coarsely faceted and unemarginate, the surface without a fine supra-orbital carina but occasionally obtusely ridged at some distance above the eyes; antennæ long and slender, the four or five outer joints larger, the eleventh pyriform and as long but scarcely so wide as the tenth; prothorax with very prominent and acute apical angles, strongly transverse, not acutely margined

or beaded at the sides; scutellum obsolete; elytra even, inflated, very widely embracing the body beneath, the inflexed part separated from the dorsum by a line strongly convex in section, the epipleuræ short, terminating anteriorly at the base of the abdomen; prosternum flat, truncate behind, abutting evenly against the equally flat and elevated mesosternum; legs long, slender, the hind tarsi short but slender, sparsely spinose and not at all grooved beneath, with long flying hairs above as on the femora and tibiæ externally, the basal joint not quite as long as the fourth, the claws evenly arcuate and slender; met-episterna wide anteriorly, narrow posteriorly, with the suture very feeble; hind coxæ transverse, separated by less than their own width. [Type *E. ventricosus* Lec.] ..... **Edrotes**

Body less stout, oblong-oval, subparallel; head nearly as in *Edrotes*, except that the epistoma is declivous and angularly produced at the middle, confounded with the front and limited posteriorly by a broad shallow transverse depression, which becomes deeper laterally, the lateral lobes thickened but not prominent, broadly rounded, the antennæ with the eleventh joint small, the eyes bounded above by distinct carinæ; prothorax with acute and prominent apical angles, closely fitted to the elytra as in *Edrotes;* scutellum wanting; elytra oblong, carinulate and granulose, the epipleuræ only extending anteriorly as far as the apex of the second ventral segment, the hind coxæ widely separated, the pro- and mesosterna as in *Edrotes;* met-episterna very broad; legs short and stout, the tarsi clothed with short spiny hairs, not sulcate beneath; body apterous as in *Edrotes*, sparsely clothed with coarse decumbent hairs, the sides of the elytra with long erect hairs. [Type *P. granulata* Champ.] .... * **Pimeliopsis**

Edrotes is represented by numerous species scattered through our entire Sonoran fauna, but *Pimeliopsis* Champ., is now known only by the type species, about 8.0 mm. in length, of which two specimens were taken by H. H. Smith at Venta de Zopilote, in Guerrero, Mexico, and, being unknown to me in nature, will not be further alluded to.

Edrotes Lec.

In this genus the pubescence, usually long and bristling, is frequently lineate on the elytra, owing to the condensation of punctures along a few longitudinal lines, which represent the low carinæ of *Pimeliopsis*, *Adesmia* and *Craniotus*. The surface is probably always polished but is frequently dull, because of a thin gray-black indument which forms upon it. The species are difficult to classify and describe in a recognizable

manner, although readily divisible into two distinct groups, the species of the first group more widely differentiated among themselves and more readily identifiable by description than the more numerous forms of the second division. An attempt to differentiate these specific, or perhaps in some cases subspecific, forms, is presented in the following table: —

Elytral punctures more or less fine and sparse, the surface more shining, the size generally larger, the geographic range more western..... 2

Elytral punctures large and close-set, with more feeble atttached granules, the surface lustre generally duller and the geographic range more eastern.....7

2 — Elytra strongly globose or oval, never very distinctly longer than wide.....3

Elytra oblong-oval, longer than wide.....6

3 — Prothorax broad, much more than half as wide as the elytra.....4

Prothorax narrow, scarcely at all wider than a single elytron.....5

4 — Form very rotund, convex, smooth and highly polished, deep black, the erect hairs very long but sparse, grayish-white, more condensed in four fine lines on each elytron; head not as wide as an elytron and very much narrower than the prothorax, very finely, sparsely and simply punctate, the second antennal joint much shorter than the fourth; prothorax between four and five times as wide as its median length, decidedly broader at base than at apex, the latter broadly, very deeply sinuate, with the angles large, strongly produced and very acute, the base transversely truncate, fitting very closely to the elytra, the sides scarcely visibly arcuate; surface very remotely and minutely punctulate, except in lateral fifth or sixth, where the surface becomes abruptly feebly rugulose in longitudinal wavy folds and with moderately coarse and well separated punctures, which are each strongly tumid externally; elytra rounded, one-half or less wider than the prothorax and seven or eight times as long as its median line, the punctures minute and very remote, less sparse in the condensed lines, each puncture immediately behind a small abrupt tubercle; abdomen strongly, moderately coarsely and rather sparsely punctate throughout, the punctures very strongly muricate. Length 9.5–10.0 mm.; width 6.0–6.7 mm. California (Colorado Desert).
ventricosus Lec.

Form equally rotund and similar in color, lustre and vestiture, except that the erect hairs are less numerous, shorter, more ashy-white and less conspicuous, the size much smaller; head nearly similar in form and sculpture but relatively a little smaller, the antennæ with the outer joints relatively much more elongate even in the male; prothorax similar in general form but not much over four times as wide as its median length, subimpunctate except abruptly

in lateral fifth, where the surface becomes rugose but not longitudinally wavy and with moderately coarse, well separated punctures, each of which is very strongly carinato-tuberculose externally; elytra fully one-half wider than the prothorax and about six times as long as its median line, sculptured nearly as in *ventricosus;* abdomen sparsely but strongly punctato-muricate, polished. Length 7.5–8.0 mm.; width 5.3–5.6 mm. Arizona (Tempe), — Warren Knaus..... .....**orbus** n. sp.

Form slightly less rotund and more elliptical, similar in color and lustre, the erect vestiture sparse, shorter, yellowish-cinereous and without trace of serial arrangement; head subequal in width to an elytron, smooth and very sparsely but distinctly punctate, the antennæ dark rufous, fulvo-pubescent apically, the apical joints elongate-triangular (♂); prothorax not quite four times as wide as its median length, in form as in the preceding, with very remote, rather small but distinct, submuricate punctures, becoming somewhat abruptly very coarse, deep, elongate and subanastomosing but not attended by definite tubercles in almost lateral fourth; elytra oval, very slightly longer than wide, fully six times as long as the prothorax but only a little more than a third wider, sparsely, very evenly but confusedly punctate, the punctures only moderately small, deep and very distinct, each attended by a very minute granule on its anterior edge; abdomen rather coarsely and somewhat closely but only slightly muricately punctate. Length 7.5 mm.; width 4.8 mm. California (Kern Co.).....**nitidus** Csy.

5 — Body rounded, deep black, polished under the indument, clothed sparsely with rather coarse, erect and yellowish-cinereous hair, rather shorter than in *ventricosus*, not in the least lineate on the elytra, and intermixed with numerous shorter recurved hairs; head not half as wide as the elytra, finely but distinctly, sparsely punctate; prothorax less than four times as wide as its median length, formed as in the preceding species, rather finely but sparsely, submuricately punctured, with a few coarse punctures scattered along the basal part and closely, coarsely and very roughly punctured toward the sides; elytra as long as wide (♂) or a little wider (♀), very finely, sparsely punctato-granose as in *ventricosus*, except that the punctures are evenly distributed and not condensed into lines, the inflexed sides more coarsely and strongly but still not very closely punctured, the disk fully twice as wide as the prothorax (♀), sensibly less (♂); abdomen rather strongly but sparsely punctato-muricate. Length 6.4–7.0 mm.; width 4.4–4.7 mm. California (Bishop, Inyo Co.), — A. Fenyes.
angusticollis n. sp.

6 — Body oblong-oval, moderately convex, black, with a feeble piceous tinge, the legs and antennæ dark rufo-piceous; erect pubescence long, fine, sparse, very pale yellowish-white, with some shorter and less erect hairs intermingled, not at all lineate on the elytra; surface highly polished; head not quite as wide as an elytron,

finely, sparsely punctate, with a rather pronounced obtuse ridge above each eye; prothorax scarcely four times as wide as its median length, of the usual form, very finely, remotely punctate, abruptly coarsely but not closely so in lateral fifth to sixth, the punctures elongate, tumid externally; elytra evidently longer than wide, very broadly and obtusely subtruncate behind, the punctures moderately small, sparse, evenly distributed, widely impressed and very distinct, each with the usual extremely minute granule attached anteriorly, the inflexed sides coarsely but sparsely impresso-punctate; abdomen coarsely but rather sparsely punctate, the punctures transverse as usual and more or less muricate. Length 7.8–8.7 mm.; width 4.7–5.25 mm. Utah (southwestern). **longipennis** n. sp.

7 — Reëntering angle between the sides of the prothorax and elytra deep and well marked..... 8

Reëntering angle very broad and shallow, the sides of the prothorax almost continuous with those of the elytra.....13

8 — Elytra strongly inflated, orbicular, not longer than wide.....9

Elytra more or less evidently elongate, more oval and less rotund...12

9 — Head sparsely punctate, not rugose toward the sides 10

Head coarsely and less sparsely punctate, rugose laterally. 11

10 — Body rounded, very convex, black, dull in lustre, the legs and antennæ slightly picescent; erect hairs long, sparse, ashy-white, intermingled with shorter and more decumbent hairs, and very feebly, indefinitely lineate on the elytra in broader lines than in the *ventricosus* group; head moderate, much narrower than an elytron, the punctures moderately coarse, sparse throughout; antennæ shorter and stouter than in *ventricosus*, the second joint much longer than the fourth and but slightly shorter than the third; prothorax about three and one-half times as wide as the median length, of the usual form, rather coarsely but sparsely punctured, becoming very coarsely and densely so in less than lateral fourth, the punctures crowded and elongate; elytra about five times as long as the median line of the prothorax, less than one-half wider, with very coarse, deep and subimpressed uniformly distributed punctures, separated by a little more than their own widths, the interspaces, bearing the shorter pubescence, not visibly punctate, the inflexed sides narrower and more convex than in the *ventricosus* group, coarsely, rather closely punctured, separated from the upper surface by a line broadly convex in section and not acute as in *ventricosus*; under surface very coarsely and closely punctate, the abdomen less coarsely and rather sparsely. Length 6.2 mm.; width 4.4 mm. Colorado. [= *Pimelia rotunda* Say] ....**rotundus** Say

Body nearly similar to *rotundus* in form and coloration but smaller and somewhat more shining, the pubescence coarser, ashy-white, scarcely lineate on the elytra, the long hairs shorter, very sparse,

the short hairs sparse and subevenly distributed; head much narrower than an elytron, rather coarsely but sparsely and evenly punctate, the antennæ scarcely longer than the head and prothorax, with the second and fourth joints equal in length and decidedly shorter than the third; prothorax formed as in *rotundus*, coarsely but very sparsely punctured, becoming very coarsely and densely so in lateral fifth; elytra almost hemispherical, six times as long as the prothorax and nearly one-half wider, coarsely and deeply punctate, with the punctures separated by notably more than their own widths, the flanks gradually inflexed and a little more coarsely and closely punctate, the interstices not evidently punctate but not smooth; under surface nearly as in *rotundus*, the first and second ventral sutures deeply impressed near the sides, as frequently the case and possibly to some extent a sexual character. Length 5.4 mm.; width 3.7 mm. Colorado (Greeley).

globosus Csy.

11 — Form rounded, convex, deep black, rather shining, the vestiture apparently sparse, shorter and less conspicuous than usual; head distinctly narrower than an elytron, more or less coarsely and sparsely punctate, becoming longitudinally rugose or plicato-rugose laterally, the second antennal joint slightly longer and notably thicker than the fourth and much shorter than the third; prothorax of the usual form, between three and four times as wide as its median length, rather coarsely but sparsely punctured, very coarsely and densely so toward the sides; elytra globose, five or six times as long as the prothorax and nearly one-half wider, very coarsely but not densely impresso-punctate, the punctures separated by twice their own widths or more, the interspaces smooth but more or less convex, with some smaller scattered punctures; under surface coarsely punctured, the abdomen more sparsely as usual. Length 6.6–6.9 mm.; width 4.5–4.6 mm. New Mexico and Colorado ....**inflatus** n. sp.

Form rounded, much smaller in size, very convex, moderately shining, deep black, the erect hairs moderately long, the shorter recurved hairs sparse and not very short, the pubescence cinereous, with a very feeble yellowish tinge, not or very indefinitely serial on the elytra; head coarsely and only moderately sparsely punctured, densely so and still more coarsely toward the sides, the antennæ nearly as in *inflatus* but with the third joint relatively less elongate; prothorax formed as in *inflatus*, very coarsely, deeply punctate, the punctures separated by about twice their own widths medially, becoming extremely coarse and densely crowded laterally; elytra globose, relatively as in *inflatus*, the surface coarsely rugose because of the very large deep and impressed punctures and the convex, impunctate and shining though slightly rugulose interspaces, which are but little wider than the punctures; abdomen very coarsely, rather closely punctured and rugose. Length 5.3 mm.; width 3.7 mm. New Mexico.....**puncticeps** n. sp

12 — Form somewhat elongate-oval, very convex, moderately dull in lustre, black, the vestiture cinereous, the erect hairs long and numerous, the shorter equally numerous, without any very evident serial arrangement on the elytra; head not very coarsely, sparsely punctured throughout, the punctures not denser but with the surface feebly rugose laterally; second antennal joint but little longer than the fourth though thicker, abruptly constricted or pedunculate at base; prothorax of the usual form but only a little more than three times as wide as its median length, sparsely and moderately coarsely punctured, the punctures very coarse and densely crowded laterally; elytra distinctly elongate-oval, not quite six times as long as the prothorax — on its median line as usual, — and very nearly one-half wider, very coarsely and deeply punctured, the punctures more perforate than in the two preceding species and separated by about twice their own widths, the interspaces sparsely strewn with punctures which are about half as wide as the others; under surface punctured as usual. Length 7.5 mm.; width 4.72 mm. Arizona.....**intermixtus** n. sp.

Form and coloration as in *intermixtus*, the lustre generally rather dull, the vestiture dark cinereous in color, rather shorter and sparser than in *intermixtus* and less conspicuous, not serial on the elytra; head smaller than usual, finely and sparsely punctured throughout, the second antennal joint equal in length to the fourth but thicker, constricted at base; prothorax as in the preceding species but less transverse, scarcely more than three times as wide as its median length, rather coarsely, sparsely but muricately punctate, gradually becoming extremely coarsely, densely so laterally; elytra evidently elongate, elliptical, between five and six times as long as the prothorax and nearly one-half wider, punctured as in *intermixtus* but less coarsely and with fewer or no intermingled smaller punctures, the punctures each with the attached granule somewhat larger than usual in this section; abdomen coarsely but rather sparsely punctured. Length 5.9–7.0 mm.; width 3.6–4.3 mm. New Mexico (Magdalena), — F. H. Snow..... .....**oblongulus** n. sp.

Form rather less elongate than in the two preceding, strongly convex, black, polished though generally dull by reason of the incrusting indument, plentifully clothed with long, bristling, unusually coarse and conspicuous flavo-cinereous hairs, the shorter not numerous, the vestiture arranged in rather distinct broad lines on the elytra; head larger than in *oblongulus*, subequal in width to an elytron, rather finely, very sparsely and subevenly punctate, the superciliary ridge pronounced; second antennal joint not quite as long as the fourth but thick, constricted at base, much shorter than the third; prothorax of the usual form, fully four times as wide as the median length, rather coarsely, somewhat sparsely punctate, very coarsely and densely so laterally; elytra only very slightly elongate, oval, nearly six times as long as the

prothorax but only about two-fifths wider, very coarsely punctured, the punctures separated by more than twice their own widths, the interspaces nearly flat and with a very few small and widely scattered punctures; under surface with the usual coarse sculpture. Length 6.3–7.3 mm.; width 4.2–4.8 mm. Arizona (Benson), — G. W. Dunn.....**lineatus** n. sp.

13 — Body somewhat elongate-oval, convex, somewhat piceous-black, the legs rufescent, the surface dull in lustre; pubescence sparse, coarse, moderately long, fulvo-cinereous in color and not definitely lineate on the elytra, rather close and conspicuous on the head, the latter relatively large, fully as wide as an elytron, rather finely, sparsely punctured, the punctures but little coarser or less sparse laterally but with the surface feebly and longitudinally rugulose; second antennal joint but little longer or thicker than the fourth, not abruptly constricted at base; prothorax of the usual form, not quite four times as wide as its median length, rather coarsely, sparsely punctate, very coarsely and densely so at the sides; elytra just visibly longer than wide, elliptical, the sides more broadly rounded toward base than usual and making a very feeble angle with the sides of the prothorax, the surface uneven because of the very large and deep, unevenly impressed punctures, which are separated by about twice their own widths, the interspaces minutely rugulose and with rather small scattered punctures. Length 6.2 mm.; width 4.2 mm. Colorado, — F. H. Snow.....**subæqualis** n. sp.

Body much more narrowly oval in form, convex, black, rather dull in lustre, the pubescence finer, sparser, somewhat less erect and shorter than in *subæqualis*, more ashy-white in color and similarly devoid of lineal arrangement on the elytra; head relatively large, fully as wide as an elytron in the apparently female type, the punctures small and sparse, rather coarser but not very close-set though somewhat muricate laterally, the second antennal joint rather longer but only slightly thicker than the fourth and not abruptly constricted at base; prothorax of the usual trapezoidal form, with straight sides, but only a little more than three times as wide as its median length, not very coarsely, remotely punctate medially, becoming gradually very coarsely and densely so laterally; elytra evidently longer than wide, about five times as long as the prothorax and barely a third wider, the sides toward base feebly rounded and making but a slight angle with the sides of the prothorax, the surface much smoother than in *subæqualis*, less coarsely and more perforately punctate, the punctures not very close-set, uneven in size; epipleuræ extending to the middle of the metasternum. Length 5.5 mm.; width 3.75 mm. Texas. **angustulus** n. sp.

There is apparently but little doubt of the specific validity of nearly all the forms above described, and there are probably as

many more still undiscovered. The almost completely denuded type of *inflatus* has remaining only the short sparse and coarse recurved hairs, but slight indication of erect discal hairs remaining, though a more enlarged view seems to show that there may have been erect hairs, represented by apparently broken stumps. The second specimen, from Colorado, is even more completely denuded and differs from the New Mexican type in a number of features, such as the less transverse and more coarsely punctate prothorax and the more circular and less coarsely punctate elytra, but some of these differences may be sexual and, as they both have the peculiar longitudinal rugulosity of the head distinguishing the species from *rotundus* and *globosus*, I have concluded to regard them as constituting a form allied to *rotundus* but specifically distinct, although I am unable to describe the vestiture satisfactorily. This does not appear to be particularly easy to remove, as shown by all the other specimens before me, and the condition of these two examples of *inflatus* is therefore somewhat mystifying.

Tribe Craniotini.

To state the various phylogenetic lines of affinity of *Craniotus* with other groups, from some of which it departs very widely in habitus, would require extended space, out of keeping with the superficial character of the present practically pioneer work in the Tentyriinæ, but the living group to which it is most closely allied is, singularly enough, the old world Adesmiini, and the resemblance here is very pronounced in general facies. It however also has some relationship with *Edrotes*, notwithstanding its very different form of body, and it may be said, in this connection, that the Mexican *Pimeliopsis*, closely related to *Edrotes*, is to some extent intermediate in that respect, especially in its less rotund outline, more differentiated prothorax and faint elevated lines on the elytra. With the Adesmiini it is particularly allied in the form and position of the coxæ, short, unevenly convex metasternum, form of the met-episterna, general outline of the body and long slender legs, although differing completely in the epipleuræ, which in *Adesmia* are narrow though subequal in width throughout and entire. The side

margin of the prothorax is entirely obliterated in *Craniotus*, more completely so than in *Edrotes* or any of the small types of Triorophini, and this character it shares with *Adesmia ulcerosa* Klug, but in *Adesmia microcephala* Sol., there is a perfect and acute side margin as in *Triorophus*, this differential feature probably serving in part as a basis for the subgeneric divisions proposed by Allard. The Adesmiini suggest, through a widely diverging line of development, some of the Asidinæ. The only known genus of the Craniotini may be defined as follows:—

Body narrow anteriorly, with inflated elytra, pubescent; head dilated and acutely prominent at the sides before the eyes, the latter transverse, convex, coarsely faceted and unemarginate as in *Edrotes* and even more prominently projecting from the flanks; surface with a broad and deep transverse groove behind the epistoma, which is broadly trapezoidal and but little produced, the apex feebly sinuate; mandibles obtusely bifid at tip, impressed externally, folding entirely beneath the exposed and apically sinuato-truncate labrum; mentum large, transversely hexagonal, deeply sinuate at apex and emarginate at base; antennæ rather long and slender, with the third joint much elongated as in *Adesmia*, the eleventh not free but small and received within the apex of the tenth, the latter being the only broadened joint; prothorax transversely suboval, not beaded at apex, base or sides; scutellum well developed, acutely pointed and elongate; elytra embracing the sides of the body as in *Edrotes*, the epipleuræ very narrow and linear but, as in Edrotini, confined to the posterior part of the elytra, gradually disappearing before the middle of the abdomen; anterior coxæ moderately separated, the intermediate a little more widely and the posterior remotely separated, briefly, transversely oval, separated from the sides of the body by three-fourths of their own width; metasternum very short, convex at the sides, the met-episterna wide, subparallel, with the suture internally arcuate; femora and tibiæ very long, slender and subcylindric, the hind tarsi comparatively short, slender, with long hairs above and shorter stiff spines beneath, not grooved. [Type *C. pubescens* Lec.]..... **Craniotus**

The eyes in *Adesmia*, although similarly transverse and convex on the flanks, are feebly sinuate anteriorly and are much more finely faceted; the apical parts of the head and mandibles are almost similar, except that the front is not dilated at the sides and the mentum not emarginate at base, and the eleventh antennal joint is free, though very small. The coxæ and metasternum in *Adesmia* are almost exactly as in *Craniotus*, but the posterior are still more widely separated, almost globular in

form and approach the sides of the body very closely, the metepisterna narrower, coming to a point behind and a more obtuse point anteriorly, with the suture strongly arcuate as in *Craniotus*. The body in *Adesmia* is glabrous and the integuments much thicker and more solid than in *Craniotus*.

Craniotus Lec.

The relationship of this genus with the Edrotini can be traced in the pubescence of the body, subtumescent elytral lines, corresponding with similar lines in *Pimeliopsis* and reduced to lines of denser punctuation and pubescence in *Edrotes*, form of the eyes, labrum and mandibles, slender antennæ, unmargined sides and base of the prothorax, position and extent of the epipleuræ and form of the legs and tarsi. It differs very greatly in the general form of the body, in which it more closely resembles *Triorophus*, in the form of the prothorax and in the large scutellum, this being wholly obsolete in both the Edrotini and Adesmiini. We have only the following type species: —

Body elongate, convex, rather shining, the elytra duller, dark blackish-brown in color, the under surface, legs and antennæ more piceo-rufous; pubescence rather short, sparse, yellowish-cinereous, subdecumbent, with less numerous erect hairs, which are very moderate in length and not at all conspicuous; head nearly as long as wide and but little narrower than the prothorax, evenly, not coarsely and rather closely punctate, the surface evenly convex, without trace of superciliary ridge; antennæ one-half longer than the head, sparsely pubescent and also bristling with erect setæ; prothorax two-fifths wider than long, parallel, the sides very evenly rounded from apex to base, the former feebly sinuato-truncate, with the angles somewhat obtuse but not at all rounded, the base transversely rectilinear, just visibly wider than the apex, the angles very obtuse and blunt; surface very convex, even, rather finely, sparsely punctate, becoming gradually somewhat coarsely and less sparsely so toward the sides and continuously down the flanks to the coxæ; elytra elongate-oval, convex; one-half longer than wide, between three and four times as long as the prothorax and twice as wide, the sides evenly arcuate to the thoracic base, without trace of humeri or callus, the base very briefly prolonged at the sides, wholly devoid of elevated margin, with extremely broadly and feebly tumid lines on which the vestiture is slightly less sparse, forming a vaguely lineate appearance; abdomen smooth, very finely, sparsely punctate. Length 11.0 mm.; width 5.6 mm. California (Colorado Desert) and Arizona (Yuma)..... **pubescens** Lec.

Horn states that this species is not rare, but I only succeeded in obtaining a single specimen and am inclined to regard it as a species seldom taken.

Tribe Zopherini.

With this remarkably isolated tribe there begins a series of genera, differing altogether from those which precede in the general habitus of the body and in many structural characters, such as the small or moderate mentum and the occurrence of fossæ for the shelter of the antennæ. I have, however, followed LeConte and Horn in associating them with the preceding genera having a large mentum, to form the subfamily Tentyriinæ, because of the closure of the middle acetabula by the sterna alone, with entire absence of trochantin. It is questionable, however, if we are not giving too great prominence to the latter character, and it would perhaps be more natural to include in the subfamily Tentyriinæ only those genera having a large mentum, and to delimit another subfamily, beginning here and including also what LeConte and Horn called the Asidinæ, holding the presence or absence of a trochantin to be of subsidiary importance. This arrangement would at least bring together generic types having a strong bond of similarity in general facies of the body, for it is very evident that the Zopherini, Stenosini and other tribes without trochantin, resemble *Nyctoporis* and the Asidini much more closely than they do any of the preceding tribes with large mentum. It is true that certain genera with large mentum, such as *Hyperops*, recall strongly some of these forms with smaller mentum, such as the Stenosini, but this resemblance is undoubtedly accidental and betokens no real relationship, any more than the very striking superficial likeness of *Salax* to *Opatrum* evinces any real affinity.

As intimated above the Zopherini are without any close relatives, except the Nosodermini and Usechini, with which they share a good many peculiar characters, such as the deep apical fossa of the abdomen and absence of epipleuræ. Besides the invisible labial palpi and presence of antennal fossæ, perhaps their most aberrant characters are the very minutely faceted

eyes, which are transverse, approximate above and largely concealed in repose and the deep transverse asexual fossa of the last ventral segment just mentioned. The genera known to me may be readily distinguished as follows: —

Elytra abruptly inflexed at the sides, the inflexed sides more or less nearly flat and having the aspect of true epipleuræ; prosternum between the coxæ forming a broad flat and medially canaliculate plate, prominent at the sides behind the coxæ; mentum lobed at each side at apex, the intermediate part of the apex transversely swollen; antennal fossæ not enlarged or posteriorly angulate at tip; body but feebly constricted at the waist. [Type *Zopherus chilensis* Gray] ..... ***Megazopherus**

Elytra not abruptly and less widely inflexed at the sides; prosternum longitudinally convex between the coxæ, not prominent at the sides; body strongly constricted at the waist, more convex.....2

2 — Antennal fossæ posteriorly angulate at the tip; mentum flat, broadly, feebly sinuate at apex; scutellum wholly obsolete; elytra each with a large rounded tubercle near the apex and sometimes with another smaller one nearer the apical angle; body always pale with black mottling. [Type *Z. mexicanus* Gray]. **Zopherus**

Antennal fossæ not posteriorly angulate at tip; mentum more uneven, frequently bi-impressed, broadly sinuate at apex, with an elevated transverse ridge along the margin; scutellum minute, triangular..3

3 — Elytra each with a large rounded flattened discal tubercle near the apical angle as in *Zopherus*, very coarsely tuberculose, the coloration black, generally with pale venose coloration at the sides and sometimes throughout. [Type *Z. limbatus* Csy.]. ***Zopherinus**

Elytra without the rounded subapical tubercles of the two preceding genera, each having a short oblique ridge at apex and impressed along the suture thence anteriorly for a short distance, the ridge differing greatly in form from the tubercle of the preceding genera; surface more or less finely tuberculose throughout, the tubercles frequently obsolete; color of the body invariably deep black without paler ornamentation. [Type *Zopherus tristis* Lec.] ..... **Zopherodes**

Each of these genera has a distinct habitus of its own, admitting of instant recognition and there can be no doubt of their reality. *Megazopherus* Csy., is Central American, extending to the northern part of South America and *Zopherus*, Mexican and Central American, one species occurring in southern Texas; *Zopherinus* Csy., has very much the same range though much less numerous in species. *Zopherodes* is purely Sonoran.

This group, together with the genera placed below in Nosodermini, was recently revised by the writer in the Canadian Entomologist (1907, p. 29 et seq.), where the above genera were originally defined.

Zopherus Gray.

This genus is widely diffused in Mexico and tropical North and South America, being represented by many species, some of which approach each other rather closely in facies, so that their circumscription is not always easy. The small additional tubercle, between the regular tubercle and the apical angles, varies a good deal in prominence and may possibly be gradually obsolescent in various forms, but, at the same time, it seems to be correlated with the form of the posterior margin of the excavation in the last ventral segment, this marginal wall being anteriorly prominent at the middle in the bituberculate apex and emarginate in the quadrituberculate. We have but a single species, which may be readily known as follows:—

Body elongate, convex, rather dull in lustre, the upper surface yellowish-white, with the median part of the pronotum and sutural parts of the elytra irregularly black, a large black subquadrate blotch in basal half of the former particularly conspicuous; head black, with a transverse pale line at base, very finely and remotely punctate; prothorax about as long as wide, twice as wide as the head, the apex much wider than the base, bisinuate, the sides slightly and subangularly dilated before the middle, thence moderately converging, rather strongly arcuate and tuberculose to the feeble sinuosity at the base, the surface smooth, finely, sparsely punctate, usually having a few small black spots at the centre of the broad lateral white regions; scutellum triangular, confined to the steeply sloping base of the elytra and scarcely entering between them; elytra elongate-oval, as wide as the prothorax and not quite twice as long, with five rows of large feeble tubercles, the sutural close-set, forming a continuous black line, the second and third rows composed of much more widely separated black tubercles on the white ground, the fourth row still more widely spaced, separated from the adjacent series by a much wider interval, the fifth again with rather close-set tubercles and at the lateral margin; apical tubercles four in number; under surface in great part black, the prothorax wholly so, the other sterna with some white spots laterally and the second and third segments each with a white blotch at each side of the middle; prosternum coarsely, coalescently punctate medially, not tuberculose, the intercoxal surface canaliculate along the middle; pos-

terior wall of the abdominal excavation very deeply and narrowly emarginate at the middle. Length 23.0–26.0 mm.; width 8.5–10.0 mm. Texas. [= *nodulosus* Horn nec Sol., and *variolosus* Hald.] ..... **haldemani** Horn [Sallé MS.].

The series of eight specimens in my cabinet hold together remarkably well and with very little variation; the species is related more especially to *reticulatus* and *marmoratus*. The authorship of the name of this species is rather uncertain; Horn wished Sallé to be credited, but the few comparative remarks made by him form the basis of a decision by Mr. Champion (Mem. III, Soc. Ent. Belg.), that he himself is the proper authority for the name. The description given above is the first that has been published so far as known to me.

The integuments in this genus are so thick and hard as to almost defy ordinary methods of mounting, and I have frequently had the point of an ordinary pin curl upward in attempting to force it into the elytron, finally being compelled to bore a hole with a steel instrument for the insertion of the pin.

Zopherodes Csy.

The geographic range of this genus is from northern Mexico to Utah and westward to the southeastern mountains of California, also occurring in Lower California, but it does not appear to extend to the Pacific Ocean, having its maximum development in Arizona, New Mexico and adjacent regions. The species are much smaller in size than in *Zopherus*, very numerous and conform to a nearly uniform type of structure and facies, so that they form fully as difficult a study as the preceding genus. The surface sculpture is much finer and closer than in *Zopherus*, and the body is uniformly black throughout in all except the *elegans*, of Horn, which presumably does not belong here and which I have been unable to observe in nature. In the species of the *tristis* type, the upper surface is coated, especially toward the sides, with a pale grayish indument, which is minutely sculptured and apparently a normal part of the integument, but this indument is not observable to any considerable extent elsewhere. The components of this genus having been recently reviewed (l. c., p. 38), I will simply add here a

number of species, for the most part since received, as follows: —

Elytra subcylindrical, more abruptly narrowed at base and toward apex as in *tristis* Lec.; pronotum strongly convex, generally very feebly impressed along the median line for a short distance at the centre of the disk 2

Elytra evenly oval in outline, the pronotum usually less convex and never impressed along the median line..... 3

2 — Form more elongate than in *tristis*, the size larger though very variable in this respect, dull in lustre, the elytra with gray indument between the tubercles laterally; head rather coarsely but sparsely punctured; prothorax nearly as long as wide (♂) or shorter (♀), very coarsely punctured, sparsely toward the middle, where the short impressed line is distinct, densely and more or less confluently punctured toward the sides posteriorly, the sides subangularly prominent near apical third, converging, arcuate and tuberculose thence to the base, the basal bead coarse and strong; elytra three-fourths longer than wide, slightly wider than the prothorax and three-fourths to four-fifths longer, more evidently wider in the female than in the male, with coarse flattened tubercles which are only vaguely lineate in arrangement and mingled with others which are smaller and more convex; prosternum and abdomen very coarsely but sparsely punctate, the former not at all tuberculose. Length 10.2–17.5 mm.; width 3.8–6.5 mm. Arizona (Baboquivari Mts.), — F. H. Snow.

variabilis n. sp.

Form more slender, smaller in size, with relatively much larger prothorax, dull in lustre, the pronotum laterally and the elytra, almost throughout between the tubercles, covered with gray indument; head remotely, rather coarsely punctate; prothorax as long as wide, obtusely subprominent at the sides behind apical third, the sides thence converging and arcuate to the apex and more converging to the base, being sinuate near the prominence and before the basal margin and tuberculose and arcuate intermedially, the surface scarcely impressed medially, sparsely and moderately coarsely punctate, only a little more closely laterally; elytra small, one-half longer than wide, distinctly narrower than the prothorax and only one-half longer, with flattened tubercles which are very uneven in size, rather sparse laterally and seriate toward the suture; prosternum and abdomen as in the preceding. Length 13.0 mm.; width 4.7 mm. Arizona (Tucson).

incrustans n. sp.

3 — Elytra tuberculose..... 4

Elytra without tubercles, the surface smooth and alutaceous or duller.....7

4 — Elytra not wider than the prothorax.....5

Elytra wider than the prothorax.. 6

5 — Form slender (♂) or rather stout (♀), convex, dull in lustre, with comparatively much more shining elytral tubercles; head not coarsely, very remotely punctate; prothorax evidently shorter than wide, the sides very obtusely and feebly prominent at apical two-fifths, thence rather feebly converging and straight, then rounded to the apex, strongly converging, broadly arcuate and tuberculate between the feeble sinuses to the base, which is much narrowed, with coarsely elevated margin; surface only moderately coarsely, scarcely at all muricately, sparsely and very irregularly punctate, more coarsely and closely only very near the sides anteriorly; elytra not quite twice as long as wide, two-thirds longer than the prothorax and not quite as wide, with large, moderately elevated, close-set and sometimes coalescent tubercles, without evident linear arrangement, the interspaces very finely, remotely, feebly and simply punctate; prosternum coarsely, irregularly foveato-tuberculose, the abdomen sparsely punctured, very coarsely basally, rather finely behind the first two segments. Length 17.0–18.0 mm.; width 5.8–6.3 mm. New Mexico (Cloudcroft), — Warren Knaus..... .....**morosus** n. sp.

Form slender, convex, dull in lustre, the elytral tubercles relatively rather strongly shining, head finely, remotely punctate; prothorax about as long as wide, the sides feebly subangulate at apical two-fifths, thence feebly converging and straight very nearly to the apex, where they become strongly rounded, moderately strongly converging, only very feebly arcuate but densely tuberculose to the base, the latter coarsely elevated; surface somewhat finely punctate, the punctures rather sparse but very uneven in distribution, each at the posterior end of a comparatively large flattened tubercle, the punctures similar laterally but with the tubercles smaller and more sharply elevated; scutellum minute, transversely rounded; elytra scarcely twice as long as wide, three-fourths longer than the prothorax and equally wide, with rather large, well separated, very strongly elevated rounded tubercles, indistinctly arranged in series, the intervals with fine, sparse, muricate punctures; prosternum evenly, strongly tuberculose, each tubercle with a very fine attendant puncture; abdomen sparsely punctured; coarsely on the first two segments. Length 15.0 mm.; width 5.2 mm. New Mexico (Fort Wingate).

verrucipennis n. sp.

6 — Body moderately stout, convex, shining; head sparsely and very coarsely punctate; prothorax not quite as long as wide, feebly but angularly dilated at apical two-fifths, the sides thence moderately converging and straight to the strong apical arcuation, more strongly converging, arcuate and tuberculose between the two sinuses to the base, the latter with an irregular elevated margin; surface coarsely, unevenly and not very sparsely punctate, the punctures muricate or subtuberculiferous, not differing much toward the sides though a little finer and less muricate posteriorly;

elytra only a little, though evidently, wider than the prothorax and four-fifths longer, fully three-fourths longer than wide, the sculpture rough in irregular transverse plicæ, feebler, sparser and mixed with some small and irregular tubercles toward the sides, the plicæ and interspaces equally shining; prosternum rather closely punctato-tuberculose, the abdomen coarsely, not densely punctured throughout. Length 17.8 mm.; width 6.7 mm. California, — Cab. Levette.....**californicus** n. sp.

Body rather less stout and convex, much more inflated posteriorly, nearly as in *ventriosus*, densely dull and without lustre; head rather coarsely, very sparsely punctured; prothorax small, nearly as long as wide, the sides broadly rounded, with a mere trace of prominence before the middle, more converging toward base but only slightly tuberculose, the basal margin thick though only slightly elevated; surface rather sparsely and somewhat irregularly, moderately coarsely punctate, the punctures very feebly muricate, closer, rather coarser and scarcely at all muricate laterally; elytra fully a fifth wider than the prothorax and nearly twice as long, barely three-fourths longer than wide, the surface with moderate and somewhat sparse punctures, each attended by a small and feeble, slightly transverse tubercle, evenly distributed but not evidently lineate in arrangement; prosternum irregularly and closely but not very strongly punctato-tuberculose, the abdomen coarsely, moderately closely punctured, gradually less coarsely posteriorly. Length 16.0 mm.; width 6.5 mm. California (Giant Forest).....**parvicollis** n. sp.

7 — Form very elongate and slender, the upper surface more feebly convex, moderately dull in lustre; head not very coarsely, sparsely punctured; prothorax fully as long as wide, the sides very feebly subprominent near apical two-fifths, thence but slightly converging and feebly arcuate, becoming gradually strongly rounded to the apex, converging posteriorly, straight for a short distance from the prominence, then moderately arcuate and tuberculose to the short basal sinus, the basal margin not very thick, abruptly and strongly elevated; surface finely, simply and sparsely punctate, becoming more coarsely and closely so only near the sides anteriorly; scutellum minute, angular; elytra very elongate, more than twice as long as wide, as wide as the prothorax to slightly narrower and nearly twice as long, the surface with very coarse, generally subtransverse and vermiculate impressed lines, strong toward base and near the apex, moderate elsewhere, also finely, sparsely, sublinearly punctate; prosternum foveate and tuberculose, the abdomen moderately coarsely punctate, coarsely so basally. Length 15.5–18.0 mm.; width 5.0–6.0 mm. Arizona, — Warren Knaus.
elongatus n. sp.

Form very slender, much smaller in size, convex, less flattened above, less dull, the lustre rather shining and simply alutaceous; head very sparsely, moderately coarsely punctate; prothorax fully as

long as wide, very sparsely, simply and rather coarsely punctate, becoming very coarsely and more closely so near the sides anteriorly, the sides and basal margin as in *elongatus*, the sides before the feeble prominence straight for a longer distance anteriorly; scutellum subobsolete; elytra equal in width to the prothorax and three-fourths longer, twice as long as wide, the surface almost perfectly smooth, with even series of widely spaced double punctures which are moderate in size, the close-set pairs of punctures arranged longitudinally, the intervals with single series of very remotely spaced solitary punctures, which are but little smaller in size; prosternum coarsely, irregularly foveate and less coarsely tuberculose, the abdomen coarsely punctured basally, gradually less coarsely posteriorly. Length 13.0 mm.; width 4.4 mm. Arizona (near Fort Apache), — Warren Knaus.

geminatus n. sp.

Enough material has now been accumulated in this genus to demonstrate three clearly marked groups of species; one, consisting of *tristis* and allies, another, of the elongate slender forms having the elytra tuberculose to smooth and inhabiting Arizona, New Mexico and adjacent regions north and south, and the third, of those species inhabiting southern California and probably also Lower California, characterized uniformly by a more dilated hind body and smaller prothorax, giving them an obviously different habitus. Five of the third group are now known, including *granicollis* Horn. The regularly lineate elytral punctures of *geminatus* are arranged in an unaccountably peculiar manner in groups of two. On closely examining these pairs of approximate punctures, it may be observed that one of them, the anterior in each case, is the setigerous puncture attending the tubercles in those forms possessing elytral tubercles, while the other is the ordinary simple puncture of the depressed spaces between the tubercles. As the tubercles are lost in the smoother forms, there is a tendency of these two systems of punctures to segregate and approximate themselves in groups of two, these binary sets forming regular lineate series. This peculiar segregation is best developed in *geminatus* though observable, to some extent, also on the much rougher and vermiculose, though non-tuberculate, elytra of *elongatus*, but Dr. Horn has not stated whether or not it occurs in *gracilis*, — a shining smooth species, with linearly punctured elytra, differing from any other known to me in the absence of an elevated basal thoracic margin.

The three forms *æqualis*, a specimen of which has recently been received from Tempe, Arizona, *variabilis* and *incrustans* are close allies of *tristis* Lec., and whether they should be regarded as subspecies or not, is a question that I am not fully able to decide at present, but it would probably harmonize more nearly with concensus of opinion, at the present day, to so consider them. *Morosus* is allied to *guttulatus*, differing in the much less rounded sides of the prothorax and closer and much more confused elytral sculpture. *Verrucipennis* is related closely to *otiosus*, and the type was included among the original cotypes of that species, but it differs in its more abbreviated elytra, with sparser, much more elevated and not so definitely serial tubercles and less rounded sides of the prothorax toward base. Inhabiting the same geographic region, though doubtless a very different station, it has evidently been evolved with *otiosus* from a common ancestor in comparatively recent times, and, although now sufficiently distinct to be easily recognized, it may possibly with more propriety be regarded as a subspecies of *otiosus*. The elytra toward the sides have some of the grayish indument, so developed in the *tristis* group, which is wanting in *otiosus*. This indument is minutely granulato-reticulate, like the rest of the surface, and is permanent; it differs wholly in nature from the pale coating in *Zopherus* and forms a remarkable peculiarity of *Zopherodes*. *Parvicollis* is related to *ventriosus* but differs in sculpture and in its very opaque sericeous integuments, and *californicus* is founded above upon the specimen which I formerly regarded as the male of *ventriosus* (l. c., p. 39); it is evidently a distinct species. *Elongatus* is allied to *lugubris* and *pudens* but differs in its more flattened upper surface and very much coarser vermiculate sculpture, and finally, *geminatus* stands alone at the foot of the series, to be followed by *gracilis*, differing from it as above stated. The individuals in *variabilis* differ in size among themselves to a very unusual degree, scarcely realizable from the measurements given. Additional specimens of *lugubris* have recently been received, collected near Flagstaff, Arizona.

The *Zopherus elegans*, of Horn, is possibly a member of the genus *Zopherinus*, the Durango specimens figured by Champ-

ion, evidently having the large rounded flattened apical tubercles of that genus, and not the small and oblique ridges of *Zopherodes*.

Tribe NOSODERMINI.

The radically different structure of the ligula and labial palpi would alone necessitate the tribal separation of *Nosoderma* and allied genera from *Zopherus*, but, in addition to this, the entire facies of the body and style of sculpture are strikingly different and the mandibles, instead of being truncate at tip as in the Zopherini, are deeply bifid, although, in view of the variability of this character in some other tribes, such as the Epitragini, it might be regarded as subsidiary in value; it is however more constant and apparently more significant in this part of the series. The genera or, in some cases perhaps more properly subgenera, are numerous, and the nine here indicated are only a part of them. Most of these minor groups possess very marked and unequivocal distinctive characters, and it undoubtedly becomes necessary to indicate them by name in any scientific scheme of classification. As far as known to me these generic groups may be briefly diagnosed as follows: —

Last two antennal joints united.....2

Last two antennal joints not united, the joints all free.....7

2 — Tarsi grooved beneath.....3

Tarsi not grooved beneath; antennæ free, not received in sternal fossæ 4

3 — Antennæ completely sheltered within deep prosternal fossæ. California region. [Type *Nosoderma diabolica* Lec.]. **Phlœodes**

Antennæ not received within fossæ, the grooves only traceable in an indefinite anterior depression. California region. [Type *Nosoderma plicata* Lec.] ..... **Noserus**

4 — Antennal joints four to eight transverse and superfoliate, the ninth as large as the two preceding united, the tenth cylindric, the eleventh enclosed within its apex, very small and scarcely prominent; prothorax with the apex bilobed. Mexico. [Type *Nosoderma denticulata* Sol.]..... * **Sesaspis**

Antennal joints four to eight similar to the preceding, moniliform or obconic, the ninth obconic, the eleventh more apparent, generally forming with the tenth a subglobular mass; scutellum subobsolete except in *Noserinus* 5

5 — Apex of the prothorax broadly arcuate medially, the sides coarsely crenulate. Cuba. [Type *Nosoderma duponcheli* Sol.]. * **Meralius**

Apex of the prothorax broadly emarginate, approximately bituberculose on the disk at the middle, with the sides coarsely crenulate; elytra cristate and tuberculose somewhat as in *Nosoderma;* prothorax short, smooth and but slightly uneven on the disk, the elytra elongate; scutellum circular, tumescent, densely scaly and conspicuous; hind coxæ much more approximate than usual. Brazil. [Type *N. annulatipes* n. sp.].....* **Noserinus**

Apex of the prothorax broadly emarginate, the sides granulose or finely tuberculate, never coarsely crenulate. Mexico.....6

6 — Mentum very small, obliquely narrowed at apex, exposing the entire ligula and the maxillæ; last three joints of the maxillary palpi subequal in length; elytra rounded at tip, with some large isolated tubercles on and above the apical declivity, none of which is marginal. [Type *Eurychora inæqualis* Say]....* **Nosoderma**

Mentum small, trapezoidal anteriorly, concealing the base of the ligula; last joint of the maxillary palpi large, almost as long as the two preceding combined; middle coxæ less widely separated; elytra subconical at tip between the two large subapical marginal tuberosities. [Type *N. squalidus* n. sp.].....* **Noserodes**

Mentum small; elytra rounded behind, without inequalities, the entire surface of the body devoid of tubercles or ridges and merely finely and equally granulated; prothorax elongate, suboval; antennæ submoniliform, the eleventh joint enclosed by the tenth, which is very large and truncate at tip. [Type *Nosoderma æqualis* Champ.].....* **Verodes**

7 — Antennæ free, the last three joints wider, forming a loose club, the sternal grooves wholly obsolete; tarsi not grooved beneath except the last joint, which is feebly impressed; mentum small, transverse as usual, broadly rounded at apex, exposing the maxillæ and ligula, the latter short, broad, tumid and densely chitinous; last three joints of the maxillary palpi subequal in length; elytra ridged, strongly tuberculose at and near the apex. Nearctic regions. [Type *Boletophagus obcordatus* Kirby].....**Phellopsis**

These genera, as indicated by the asterisks, are nearly all foreign to our own territory. *Sesaspis* (n. gen.) is founded upon a very remarkable species, which is well described by Solier, but which was not rediscovered by the workers on the "Biologia." *Meralius* (n. gen.) represents a type peculiar to the Caribbean fauna, and *Verodes* (n. gen.) is founded upon a peculiar species recently made known by Mr. Champion in the epoch-making publication referred to. *Noserinus* (n. gen.) is

a peculiar South American type, distinguished from any other by the distinct scutellum, among other characters.[1] But little more can be said of these genera at present, as all except one of the types above noted are unrepresented in my cabinet, but they doubtless possess many peculiar structural characters besides those which I have inferred from published drawings and descriptions.

Phlœodes Lec.

The mentum in this genus differs greatly from that of *Nosoderma* in being emarginate at the middle of the apex; it is small, leaving the maxillæ exposed at the sides but covers most of the ligula and the base of the labial palpi; its surface is impressed along the middle, more broadly toward base, and is densely punctured and squamose throughout. The surface of the body is very densely covered throughout with small decumbent strigose scales, through which smooth shining tubercles protrude, and the surface of the elytra is very roughly and densely pitted, evenly rounded at apex and without ridges or large tuberosities. Along the median line of each elytron there are three small patches of a deep velvety-black color, which upon closer examination, prove to be composed of very short, extremely dense and more hair-like vestiture standing erect. The sexual characters of *Phlœodes* are very obvious and peculiar but do not appear to have been observed hitherto. The male is character-

[1] The type of this remarkable genus, which differs from any of the North American genera, not only in its well developed scutellum and approximate hind coxæ, but in having true elytral epipleuræ, obsolescent posteriorly, may be described as follows: —

Form rather slender and somewhat convex, piceo-rufous, the upper surface moderately shining, in great part glabrous, except the dense pale scales along the sides of the body, on the elytral crests and tubercles and on the legs, the tibiæ being broadly banded at the middle with black scales; head with two short longitudinal furrows; prothorax transverse, constricted near the base, equally wide at apex and base, the surface subglabrous and but slightly uneven, the lateral edges arcuate, coarsely crenulate and the apex approximately bituberculate: elytra with distinct series of punctures, wider than the prothorax and between three and four times as long, rather attenuate posteriorly, obtusely rounded at tip, with a median crest on each elytron to slightly behind the middle and some subapical tubercles. Length 15.8 mm.: width 5.8 mm. Brazil (Blumenau).....*annulatipes n. sp.

This species is evidently related to *dormeanum* Fairm., from Minas Geraes.

ized by a large tumidity, bearing an elongate pubescent patch surrounded by a convex margin, on the under surface of each femur near the base, this being wholly wanting in the female.

The transverse excavation of the fifth ventral is very large, occupying nearly the entire segment, and has at the bottom an obliquely elevated, flat, posteriorly trapezoidal surface feebly emarginate at tip. The blackish-brown scales of the elytra become whitish, although structurally unaltered, on the apical declivity of many species. The forms then known to me were briefly diagnosed recently (Can. Ent., 1907, p. 42) and, although the status of some of them seemed doubtful, they appear to be more certainly validated by additional material lately received, the type of *elongatus* being perfectly duplicated by two specimens marked "San Diego," received from Professor Snow, the two original examples of *ovipennis* by another agreeing perfectly, marked "S. Cal.," on the label, and the original type of *scaber*, collected by Dunn, by another marked "Julian." The two original male types of *latipennis*, characterized by a prothorax unusually narrowed toward base and much narrower than the elytra, are matched well by another specimen, female, without definite locality. The following form is to be placed near *angustus*: —

Body very narrow and elongate, smaller in size, densely clothed throughout with a gray-brown scaly indument not paler posteriorly, the velvety spots of the elytra not black but a more reddish-brown; head bi-impressed, sparsely tuberculose throughout; prothorax a little longer than wide, parallel and rounded at the sides in apical three-fifths, then strongly, sinuously narrowed to the base, which is relatively much narrowed and distinctly narrower than the base of the elytra, the median parts of the surface moderately elevated, sparsely strewn with coarse tubercles, the concave lateral parts largely devoid of tubercles except toward the sides anteriorly; elytra two-thirds longer than wide and two-thirds longer and but slightly wider than the prothorax, deeply sinuate at base, the surface flat above, abruptly declivous at the sides and apex, very roughly and irregularly pitted and with the tubercles small and unusually remotely scattered throughout. Length 16.0 mm.; width 6.0 mm. California (locality unrecorded)...**remotus** n. sp.

This species is represented before me by a single male, the elongate pubescent area, at basal third of the femora, unusually

clearly delimited by a swollen elliptical ring at the summit of a moderate but rather abruptly formed prominence. The paler color of the elytral vestiture does not appear to be accidental in the type.

Noserus Lec.

The sexual characters in this genus are similar to those of *Phlœodes*, except that the tumescent pubescent fovea surrounded by a tumid glabrous black ring on the under surface of the femora near basal third, characterizing the male, is not greatly elongate, as in that genus, but nearly circular. In this character therefore, the genus is very closely related to *Phlœodes*, but in many others it differs profoundly. The labial palpi are similarly large and thick, attached at the sides of the ligula, which is narrow and projecting well beyond the apex of the mentum, but the latter, though generally similar in size and form and covering the base of the palpi, has its apex narrowly and declivously produced and its surface longitudinally and rather narrowly sulcate anteriorly; the last joint of the maxillary palpi is similarly obliquely ovoidal and obtusely pointed, but is a little larger. The antennæ are nearly similar, the first nine joints being feebly obtrapezoidal and roughly sculptured and the globular tenth and eleventh, combined, smooth, though here less completely polished than in *Phlœodes*, but in the complete absence of the abruptly excavated *Zopherus*-like furrow for the reception of the antennæ, the propleuræ being merely indefinitely and moderately depressed anteriorly, we have a really radical difference between the two genera; this is supplemented by the elytral ridges and apical tuberosities of *Noserus*, which are not even suggested in *Phlœodes*. In the present genus the transverse excavation of the fifth ventral occupies only a little more than basal half of the segment; it is broadly, evenly sinuate posteriorly, the bottom rising gradually from the base posteriorly, where it is nearly at the level of the elevated hind margin and separated therefrom by a narrow and deep ambient sulcus. The specific or subspecific forms are quite as difficult to define as in *Phlœodes*, but two before me, besides those previously defined (l. c., p. 43), may be outlined as follows: —

Surface depressed and nearly flat as in *plicatus*, similarly densely covered with a thick brown indument of close-set scale-like suberect hairs, mingled with hard earthy material, the tubercles with longer, stout, reclined and curved fulvous subsquamoid bristles; head remotely bi-impressed, with small sparse black tubercles and fulvous bristles; prothorax not quite as long as wide, rounded at the sides, the latter converging toward base and becoming briefly sinuate at the basal margin, the surface with two sinuous ridges and scattered tubercles nearly as in *plicatus;* elytra with the ridges and posterior tuberosities similarly placed but much feebler, the small black tubercles penetrating the crust, finer and more remotely scattered. Length 15.5–16.5 mm.; width 5.7–5.9 mm. California (Los Angeles Co.).....**corrosus** n. sp.

Surface much more convex than in any other species, the form stout, parallel, with thick and dense, multi-fissured dark indument; head impressed, nearly smooth, with small scattered tubercles; prothorax not quite as long as wide, the sides parallel and arcuate, becoming moderately convergent and feebly arcuate in basal three-fifths, feebly sinuate at the obtuse basal angles, the base broadly arcuate; surface with the sinuous ridges narrow, feeble and wholly interrupted at the middle of their length, the surface at the sides more coarsely and roughly sculptured than in *plicatus*, the scattered tubercles nearly similar; elytra a little broader and relatively shorter than in *plicatus* but almost similarly ridged and tuberose, the large irregular indentations much deeper, the tubercles fine and remotely scattered. Length 16.0 mm.; width 6.5 mm. California..... .....**convexulus** n. sp.

Corrosus is represented by two similar females and *convexulus* by a single female, from an unrecorded locality of the State; it is the broadest and least flattened form known thus far. I believe that the genus *Noserus* will prove to be confined to the true Pacific coast fauna, with its very close relative *Phlœodes*, and that the species described from Texas by Dr. Horn, under the name *emarginatus*, will prove to be generically different, possibly belonging to a Mexican type related more closely to *Nosoderma*.

Nosoderma Sol.

I have here restricted this genus to those species having the elytra almost evenly rounded behind, with large isolated tuberosities scattered over posterior half, none of which is strictly marginal and with longitudinal, more or less incomplete or interrupted ridges thence to the base, the mentum very small, transverse, obliquely narrowed and narrowly truncate ante-

riorly, exposing the entire maxillæ and ligula, the latter narrow, with the palpi inserted in large latero-dorsal foveæ in front of the mentum and wholly exposed, the mentum flat and very coarsely, not densely punctate. The last joint of the maxillary palpi is longer and, especially, much broader, than the third, with its apex compressed and broadly truncate, not obtusely pointed as in the preceding genera. The antennæ are perfectly free, there being no trace of propleural sulcus, and the joints are feebly obtrapezoidal, not very roughly sculptured, the third much longer than the second or fourth, the ninth larger than the eighth, more obtriangular and not transverse, somewhat narrower than the combined last two joints, which are subglobular, with transverse suture and spongiose apex. The surface of the body is not always covered with indument, the integuments frequently being clean and more or less opaque between the small shining tubercles, the vestiture fulvous. The abdominal excavation occupies at least basal two-thirds of the fifth segment and is nearly as in *Voserus*. The male has a large and elongate-oval, smooth and feebly convex, finely punctate and subglabrous elevation at the base of the under surface of the middle and posterior femora, a much smaller feeble shining tubercle near the base of the anterior femora, and, sometimes, as in *senex*, a smooth punctate beveling at the tibial apex below, the female having no trace of these structures and the femora a little more slender than in the male. The species are very numerous, the type being quite indeterminate and necessarily to be fixed anew,[1] but *morbillosa* and

[1] The species named *Eurychora inæqualis* by Say, may be definitely described and the type reëstablished as follows: —

Form moderately depressed, parallel, nearly as in *senex* but larger and with the elytra more gradually, arcuately narrowed behind to the more acute apex, which is more strongly, angularly emarginate at the suture, the angles obtusely prominent, black, the vestiture fine, sparse and inconspicuous; head sparsely punctured, reflexed at the sides as usual, more broadly sinuate at apex than in *senex*, the prothorax subquadrate, similarly sculptured, except that the tubercles are smaller and more convex, the sides more angulate just before the middle and the basal angles more acute, decidedly diverging and prominent; elytra similarly sculptured, with smaller and less flattened tubercles, the humeri much more exposed at base beyond the thoracic angles, the posterior tuberosities much larger and studded more closely and conspicuously with the small shining tubercles; under surface with

vicina, of Solier, are certainly not identical with Say's species and are both valid; in addition *exsculpta* and *carinata* Champ., and probably *asperata*, *scabrosa* and similar described forms, will enter the genus. The six following can be described at the present time as typical species: —

Pronotum not elevated along the median line, its base extending laterally beyond the basal angles of the elytra, the latter each with three tuberosities at the summit of the apical declivity forming an equilateral triangle, with its base transverse. Body parallel, moderately stout and not very depressed, deep black, dull, the vestiture decumbent, rather dense, consisting of fulvous squamiform hairs; head sparsely punctured, not tuberculose, elevated at the sides; prothorax subquadrate, as long as wide, the sides rounding and converging near the apex, gradually and very feebly converging basally and nearly straight to the right, blunt and somewhat prominent basal angles, the base broadly, arcuately lobed; surface with two strong sinuous ridges, the intermediate space broadly concave behind, narrowest at the middle, the shining tubercles confined mostly to the summits of the ridges but also scattered broadly toward apex and near the sides; elytra coarsely pitted, a little wider than the prothorax and not quite twice as long, the humeri obliquely truncate, the base sinuate, each elytron with a narrow, strongly elevated and nearly straight ridge along the median line from the basal margin to a little before the middle, and with two smaller, more elongate tuberosities before the triangle of three above mentioned, the shining tubercles small and subevenly scattered throughout; under surface sparsely squamopubescent and tuberculose throughout. Male with the elongate tumescent glabrous area of the two posterior pairs of femora finely punctate, the tubercle of the anterior pair similar and elongate, though only about three-fourths as long. Length 17.0–18.0 mm.; width 6.0–6.7 mm. Mexico (Guerrero), — Baron.

* **championi** n. sp.

Pronotum flattened along the median line and without the oval basal impression of *championi*, the elytra with three much smaller tuberosities at the upper part of the declivity arranged as in that species. Body narrower and much more elongate, parallel, somewhat convex, black and dull, not very densely clothed with narrow and decumbent, dark brown scales, which are rather sparse and more hair-like on the head and pronotum; head somewhat rugosely

the fine scattered tubercles less flattened. Length 15.2 mm.; width 5.8 mm. (♀). Mexico (Jalapa). — Höge.....***inæqualis** Say

It is probable that Say's specimens came from the high country back of Vera Cruz, and, studying his description carefully and considering the acute and prominent basal angles of the prothorax, mentioned in the description, as well as the absence of any note on the pubescence, there can be but little doubt that the form here described is really the one which Say had before him.

punctured, obliquely reflexed at the sides; prothorax scarcely as long as wide, widest and laterally subangulate at basal third, the sides thence feebly converging and nearly straight almost to the obliquely rounded apical angles and more convergent and almost straight to the very obtuse, blunt and not at all prominent basal angles, the base very broadly, feebly lobed, the lobe broadly and rectilinearly truncate; surface with the two sinuous ridges very feeble, deeply impressed behind the middle at each side, the shining black tubercles moderately large, close-set throughout, except narrowly along the median line posteriorly and along the inner and outer slopes of the ridges, those areas being devoid of tubercles; elytra fully twice as long as wide, more than twice as long as the prothorax and much wider, parallel, circularly rounded behind, finely emarginate at the suture, the humeri obliquely subprominent, the sides behind them feebly sinuate, the surface of each with a feeble ridge at outer third from the base for two-fifths the length, another at inner third from just before the middle to the apex, becoming irregular behind and including the inner of the three tuberosities, and a very fine short ridge externally near the middle, the shining tubercles small and rather sparse; prosternum concave between the coxæ. Length 18.0 mm.; width 6.0 mm. Mexico (Jalapa)..... .....* **longipennis** n. sp.

Pronotum elevated feebly along the median line, more broadly behind and separated from the sinuous ridges by broad feeble sinuous channels, the base not extending laterally beyond the basal angles of the elytra, the latter each with three tuberosities at the upper part of the declivity forming a more elongate triangle, with its longest base parallel to the suture 2

2 — Body parallel, slightly convex, black, the decumbent fulvous squamiform hairs evenly, though not at all densely, distributed; head obliquely elevated at the sides, simply strongly punctured anteriorly and laterally but densely tuberculose posteriorly; prothorax widest before the middle, about a sixth wider than long, parallel, the sides broadly, subevenly arcuate to the slightly obtuse and not rounded but non-prominent basal angles, the base broadly, arcuately lobed, the two sinuous ridges moderate, gradually flattening out anteriorly, the surface thickly studded throughout with large convex and polished tubercles, wanting in the concavity just without the sinuous ridges near the middle; elytra evidently wider than the prothorax and twice as long, the humeri feebly oblique, extending laterally beyond the thoracic angles, the base broadly sinuate; surface unevenly and feebly pitted and with scattered tubercles, smaller and sparser than those of the pronotum, though equally large in single close lines on the summits of the ridges, the latter short and indefinable, one at the base of each elytron inside the median line, another, feeble, on the median line from near the base to about the middle and another, similarly feeble, outside the median line from basal fourth to behind the middle, the humeri also tumid; under surface finely, sparsely pubescent

and with small tubercles throughout. Male having the shining femoral swelling of the two posterior pairs rather coarsely, closely punctulate and feebly pubescent, that of the anterior pair very small and rugose, inconspicuous. Length 16.0 mm.; width 6.25 mm. Mexico (Guerrero), — Baron .....* **brevicollis** n. sp.

Body nearly similar but rather narrower and less convex, the decumbent squamiform fulvous hairs very sparse but condensed on the elytral tuberosities, the general aspect of the surface subglabrous and deep black; head punctate anteriorly and more coarsely and closely so laterally, very feebly and sparsely tuberculose basally; prothorax nearly as long as wide, parallel, the sides broadly rounded, more arcuate and converging anteriorly, broadly sinuate before the basal angles, which are right and slightly blunt but somewhat prominent; surface studded plentifully with large shining tubercles over all the elevations and near the sides, the sinuous ridges moderate; elytra but slightly wider than the prothorax and not quite twice as long, the humeri but feebly tumid and oblique, the basal angles falling exactly in longitudinal line with the thoracic angles, the base broadly sinuate; surface very coarsely and irregularly pitted, the ridges corresponding in position with those of *brevicollis* but much stronger, the shining tubercles scattered throughout, variable in size; under surface nearly as in *brevicollis*. Male with the elongate-elliptical shining femoral spots of the two posterior pairs rather finely, not densely punctulate and sparsely pubescent, that of the anterior pair very much smaller but elongate-elliptic, punctate and distinct. Length 15.3 mm.; width 5.75–6.1 mm. Mexico (Guerrero), — Baron.

* **subglabra** n. sp.

Body nearly as in *brevicollis* but with a much less abbreviated prothorax, which is in general similar in form but with the basal angles strongly, abruptly everted, acute and very prominent, and the shining black tubercles smaller and sparser, though similarly distributed, the sinuous ridges stronger and more abruptly flexed outward before the middle; elytra similar in form but with the rows of foveæ more regular, the pits deeper and more clearly visible, slightly elongate, the three basal ridges in echelon; subapical tuberosities and polished black tubercles nearly similar, the latter, on the whole, smaller though similarly unequal in size and decidedly less numerous, the humeri more prominently elevated; abdomen with much smaller and sparser tubercles. Length 17.5 mm.; width 6.75 mm. Mexico (Guerrero), — H. H. Smith.

* **prominens** n. sp.

Body smaller and much more depressed, deep black, feebly shining, very sparsely clothed with small narrow brown scales; head coarsely, rather closely and simply punctate, more finely posteriorly, the sides reflexed as usual; prothorax nearly as long as wide, widest slightly before the middle, the sides evenly rounding and broadly converging anteriorly, the apex two-thirds as wide as

the base, very feebly converging and straight posteriorly to the rectangular, somewhat blunt and scarcely prominent basal angles, the base broadly lobed in circular arc, sinuate laterally as usual; surface with the sinuous ridges strong, terminating at almost equal distances from base and apex, the median line also feebly and broadly tumid, except just before the middle, broadly flat along the sides from near the apex almost to the base, the shining tubercles peculiar, large, closely crowded along the ridges and scattered medially toward apex and broadly toward base and sides, wanting on the inner and outer slopes of the ridges and in the median depressed space before the middle, very low and flat throughout; elytra not at all wider than the prothorax and only three-fifths longer, broadly depressed suturally, the basal ridge at the middle short, the ridge at outer third from near the base to behind the middle of each strong, the short ridge at the middle externally very feeble, the three subapical tuberosities small but very strong and abrupt, the surface very coarsely, closely, confusedly and unevenly pitted throughout and with unusually large, very flat, irregular tubercles, larger and closer on the elevations; under surface with smaller flattened tubercles, the prosternum concave throughout along the middle. Length 13.5 mm.; width 5.28 mm. (♂). Mexico (Las Vigas), — Höge.....* **senex** n. sp.

These species are all allied to *inæqualis* Say, and *vicina* Sol., but *morbillosa* Sol., differs in its broader form and in having the basal ridge of the elytra anteriorly protuberant upon the pronotum; *championi* is described from two males and one female; *senex* and *subglabra* each from two males and *brevicollis* from a single male example, *prominens* from the female. The male seems to be much more common than the female and there is very little sexual difference in the general form of the body, the female being very slightly the stouter and perhaps usually with the vestiture somewhat denser. *Longipennis* is described from the female, and when compared with the female of *exsculpta*, with which it is closely allied, is seen to differ in its much larger size, in the finer, sparser and more hair-like vestiture of the head and pronotum, shorter medial ridge of the elytra and differently arranged prominences near the apex; the scales on the head of *exsculpta* are broad and denser and the periphery of the elytra posteriorly more coarsely and strongly crenulate.

Noserodes n. gen.

This genus is allied rather closely to *Nosoderma*, but has the small mentum rather more truncate at apex, the ligula shorter

and broader, with the palpal foveæ only just exposed, the last palpal joint much larger, the ninth antennal joint differing but little from the eighth, the combined and oval tenth and eleventh joints relatively much larger, the abdominal excavation still larger and with more depressed, even floor, and the elytral tuberosities altogether different. The small shining tubercles of the upper surface are much finer, and the surface is concealed by a generally denser earthy indument, from which project numerous longer, stiffer, recurved and squamiform hairs or narrow scales, usually fulvous in color. The elytra have a feeble lateral ridge from the humeri, terminating at the anterior limit of the apical arcuation in a prominent marginal tuberosity, somewhat as in *Phellopsis*, and there is also a submedian ridge on each elytron, terminating, at the summit of the apical declivity, in another prominent tuberosity. The type species before me may be described as follows: —

Body rather slender, parallel, depressed, black, clothed evenly and rather closely with narrow recurved, subdecumbent and fulvous scales, the surface between them largely concealed by earthy indument; head with the long oblique sutures distinct, gradually elevated laterally, nearly smooth and dull but with some scattered black granules; prothorax not quite as long as wide, the sides parallel and nearly straight, arcuately converging anteriorly to the rounded apical angles, abruptly and rather strongly converging and almost straight in basal third, becoming feebly sinuate before the basal angles, which are right and slightly prominent, the base feebly arcuate, closely applied to the base of the elytra; surface feebly elevated and broadly convex along the middle, except toward apex, and with two impressions at each side of the ridge, the four forming a central square, also more feebly impressed in the middle toward the sides and toward the basal angles, the black tubercles small, evenly distributed and moderately sparse; elytra a little wider than the prothorax and three-fourths longer, the humeri rather prominent but broadly, obliquely rounded, the sides behind them sinuate for a short distance, then parallel and feebly arcuate to the strong subapical tuberosity, parabolic apically, feebly sinuate at the suture; surface with a few rows of very coarse but indistinct, moderately impressed and irregularly rounded foveæ, each elytron with a median ridge from the base to apical fourth, where it ends abruptly in a more pronounced tuberosity and a short ridge from the base to basal fifth or sixth, between the principal ridge and the feebly elevated suture, the polished black tubercles very fine and remotely scattered; under surface with short, coarse, sparse hairs and numerous small tubercles, which are a

little coarser on the prosternum than elsewhere. Length 15.0 mm.; width 5.6 mm. Costa Rica (Chiriqui)...* **squalidus** n. sp.

The single specimen is a female, so that I am unable to describe the secondary sexual characters of the male, which, however, undoubtedly affect the femora as in the preceding genera. This genus will include also such species as *Nosoderma zunilensis* and *guatemalensis*, and perhaps, though less certainly, *venusta* and *lutosa*, recently described by Mr. Champion. *Guatemalensis* differs from *squalidus* in its much broader form, smaller, deeper and very much more distinct serial foveæ of the elytra, and in the rounded — not conical — subapical tuberosity at the side margin of each, also in the flat and not elevated, suture. Notwithstanding its much narrower and more elongate form and correspondingly different facies, I believe that *Nosoderma sparsa* Champ., will enter this genus as an aberrant modification.

Phellopsis Lec.

In its 11-jointed antennæ, having a broader club composed of three perfectly free joints, less anteriorly narrowed and more transversely parallelogrammic mentum, which is simply obliquely truncate at the apical angles, transversely tumid, dense and coarsely sculptured ligula and complete absence of the remarkable transverse excavation in the apical margin of the penultimate ventral segment, characterizing all of the preceding genera, *Phellopsis* is widely isolated. It also inhabits a totally different zoölogical faunal region, and its nearest relatives will probably be found in Siberia and Japan. I have been unable to discover any of the singular male sexual characters affecting the femora in the preceding generic types, and do not know of any certain way to distinguish the sexes externally. No new forms have come to light since my recent revision (l. c., p. 44), to which the reader is referred.

Tribe Usechini.

In this tribe the body is very small in size, when compared with the two preceding, though closely allied in general facies and in its coarsely sculptured, rough and subopaque integuments. The Usechini differ considerably in structure also, having the

eyes coarsely faceted, though flattened and widely separated above, as in Nosodermini, and so constantly covered by the prothorax that it is very rarely an example can be found, in which they are even partially observable. The large deep antennal fossæ are at the sides of the prothorax, wholly invisible from below and also invisible from above anteriorly, though broadly and dorsally exposed and enlarged posteriorly. The antennæ are short, thick and compact throughout, the last three joints wider. The tribe is confined to the true Pacific coast fauna and there is but a single genus, which can be defined as follows: —

Body oblong-oval, moderately depressed, the mouth-parts small; mentum very small, completely exposing the maxillæ at the sides and the ligula in front, parallel at the sides in basal half, trapezoidal in front; ligula small, narrow; palpi slender and small in size, the last joint of the maxillary elongate-fusiform, as long as the two preceding combined, obtusely pointed and hollowed at tip, the basal joint minute; mandibles slender apically, deeply bifid at tip, the lobes very acute, the upper but little the longer; antennæ short, stout, 11-jointed, the basal joint smaller than the second and deeply seated in the antennal fovea, the second as long as the next two combined; epistoma short, broadly truncate, the labrum short and transverse, truncate; scutellum minute, forming a long and very slender pointed wedge between the elytra, the latter moderately inflexed, without true epipleuræ but but with the inflexed surface rapidly broadening, flat and marked externally by a rough subcariniform line toward base; metasternum about as long as the first ventral, the episterna extremely narrow and linear; ventral sutures all very coarse and deeply excavated throughout, the fifth segment with a large and moderately deep, transverse impression, interrupted at the middle, the lateral margin of all the segments narrowly tumescent and separated from the rest of the surface by a fine deep sulcus, which is obsolete only at the extreme apices of the segments; coxæ rather widely separated, the anterior acetabula surrounded by an ambient prosternal gutter, the intercoxal process short, horizontal, free, widely truncate, with its median part between the gutters excavated and slightly more advanced posteriorly; legs rather short and moderately stout, the tibial spurs obsolete or excessively small, the tarsi short but slender, with stiff inclined hairs beneath, the basal joint of the posterior as long as the next two combined and a little shorter than the fourth, the claws rather small and slender. [Type *U. lacerta* Mots.]..... **Usechus**

The above description is very detailed, as I am unaware of any even passably full diagnosis of this remarkable genus.

The description of the antennæ given by LeConte and Horn in the classification, is unaccountably erroneous.

Usechus Mots.

The species of this genus are few in number and live under the loose bark of fallen trees, the two before me may be briefly defined as follows: —

Form stout, oblong-oval, blackish-piceous to paler in color, rough but with the surface somewhat shining; head small, simply, moderately coarsely and sparsely punctate above and beneath, each puncture with a short stiff yellow hair; prothorax as long as wide, widest and laterally subangularly prominent at the middle, the sides thence strongly converging and nearly straight to the apex and feebly converging and bisinuate to the basal angles, which are right and not rounded; base broadly, arcuately lobed, sinuate near the angles, much wider than the apex, which is evenly and feebly sinuato-truncate from side to side; disk feebly impressed along the middle from the apex, more broadly posteriorly, the impression obsolete near basal third, the sides of the impression feebly prominent, the entire surface coarsely but not densely tuberculose and with an elongate-oval pit at the middle of the base, the side margins strongly reflexed throughout the length; prosternum with coarse tubercles like those of the upper surface, each tubercle throughout with a stiff yellow hair; elytra one-half longer than wide or less, a little wider than the prothorax and three-fourths or more longer, the sides parallel and feebly arcuate from the unrounded, reflexed humeri to the subapical tuberosity, the apex between the tubercles parabolic; surface with coarse grooves, which are very coarsely punctate, the alternate intervals carinate, the short yellow hairs more abundant on the ridges; abdomen very coarsely, not densely punctate. Length 3.1–5.5 mm.; width 1.4–2.1 mm. California (Mendocino to Sta. Cruz).

lacerta Mots.

Form less stout and very much smaller in size, brown-black to piceo-testaceous, dull in lustre; head finely and sparsely punctate; prothorax nearly similar in form but with the impression obsolete near the middle, with the basal pit deeper and more circular, the antennal fossæ extending further posteriorly and to a slight distance behind the middle, and the tubercles above and beneath smaller, feebler, denser and less well defined, the pubescence longer and rather finer; elytra similar in general form and coarse sculpture, the ridge nearest the suture much swollen at base as in *lacerta*, the pubescence longer and more nucleated in spots along the ridges and denser on the basal enlargement of the inner ridge; abdomen strikingly different in sculpture, being almost impunctate toward the sides and much more finely punctured elsewhere, except on the basal segment; impression of the fifth

segment much feebler, almost obsolete. Length 2.9–4.3 mm.; width 1.18–1.6 mm. California (Humboldt Co.)...**nucleatus** Csy.

Both of these species are represented before me by large series, but I have not recognized any external secondary sexual characters. The great extension of the prosternum before the coxæ and its pronounced tuberculose sculpture, similar to that of the upper surface, while the entire remainder of the under surface is simply punctate, is a rather noticeable character of the genus.

Tribe ARÆOSCHIZINI.

In this tribe and the Stenosini, with which it is usually confounded by reason of the general form of the body and antennæ, the fifth ventral segment loses the very peculiar transverse excavation characterizing the three preceding tribal groups and becomes unmodified, its surface corresponding with the general convexity of the abdomen; it is rounded behind and a little shorter than the two preceding combined, but, it should be remarked, there is also an entirely different peculiarity of the abdomen in the present tribe, the third suture being very strongly sinuate and notably more strongly so than the fourth. The tribe resembles the Stenosini in the small size and elongate, moderately convex form of the body, thick perfoliate setose or squamose antennæ and some other characters, but differs in the complete absence of elytral epipleuræ, as in the three preceding tribes, these being very well developed in the Stenosini, in the presence of elytral ridges, which are wanting in that tribe, and in the much larger mentum, concealing the entire ligula. With the Adelostomini, however, it is very much more closely allied, differing in its smaller mentum, exposing the maxillæ at the sides, the maxillæ being completely concealed but the ligula uncovered in that tribe, and in the very small terminal joint of the antennæ, but resembling it in the absence of elytral epipleuræ and presence of dorsal ridges. We have but a single genus as follows:—

Form elongate, moderately convex, the hind body pedunculate, moderately inflated, elongate-oval, without humeral angles, the hind wings wanting; head elongate-oval, the clypeus very large, as long as the entire remainder but not separated by a transverse suture, the lateral oblique impressions deep, the lateral lobes very

short and reflexed, the median part broadly rounded anteriorly, with its apex broadly sinuate and finely, obtusely pectinate, covering completely all the mouth-parts; mentum rather large, flat, slightly transverse, broadly truncate at apex, narrowed toward base, exposing the maxillæ but entirely covering the short and extremely broad ligula, the palpi slender, the last joint of the maxillary elongate-oval, as long as the two preceding combined; basal margin of the buccal cavity reflexed, the side-pieces acute and prominent; mandibles bifid at tip; eyes completely divided, coarsely faceted, the upper part elongate, sunken deeply between the prominent lateral margin and a strong supra-orbital ridge, the inferior part very small, consisting of three to five facets; antennæ about as long as the head and half the prothorax, stout, compressed, perfoliate, cylindric, the tenth joint a little larger, the eleventh very small and partially within the apex of the tenth, clothed throughout with elongate yellowish scales; neck narrow, less than half as wide as the head; prothorax cordate, small, slightly elongate as a rule; scutellum triangular, scarcely passing the basal declivity of the elytra, the latter not margined at base, costate, feebly inflexed beneath; prosternum well developed before the coxæ and slightly tumid along the middle, the intercoxal process constricted anteriorly, expanding and deflexed behind; metasternum shorter than the first ventral, the episterna narrow, with the suture represented by a more or less impressed series of coarse punctures; abdomen convex, the first two sutures nearly straight, the third strongly, the fourth less strongly, sinuate in even arc; coxæ globular, moderately separated, the posterior slightly wider than long; legs rather short, stout, the tarsi short and stout, longer and less stout in the *armatus* group, the basal joint sometimes but little longer than the second, the claws small, slender and arcuate. Sonoran regions. [Type *A. costipennis* Lec.].....**Araeoschizus**

A full diagnosis of this genus, also, is given herewith, because its true affinities seem to have escaped LeConte, Lacordaire and Horn, who compare it with *Stenosis* and not with *Adelostoma*.

Araeoschizus Lec.

This genus is widely diffused throughout the Sonoran fauna of our southwestern States and northern Mexico, from which latter region a species was described by Mr. Champion, in the "Biologia," under the name *mexicanus;* the various species occur under stones in very dry regions and are said to be very sluggish in their movements and sometimes found with ants. The material in my cabinet appears to pertain to eleven species, which may be recognized by the following descriptions:—

Vestiture of the elytral ridges erect and bristling; femora unarmed throughout..... 2

Vestiture decumbent or strongly inclined and not bristling.....7

2 — The vestiture of the ridges having the form of stiff hairs.....3

The vestiture of the ridges formed of elongate scales..... 6

3 — Eyes widely divided, more sunken, the upper part narrower, the lower composed of only three or four facets, the canthus evenly joining the supra-antennal prominence, without break.....4

Eyes more convex, wider, less sunken, only barely divided by the posterior canthus, which becomes very fine anteriorly and subdisconnected from the supra-antennal prominence, the lower lobe of five facets and not so sunken..... 5

4 — Body a little larger and stouter, dark brown, densely and roughly punctured and with narrow fulvous scales anteriorly; head oblong-elongate, rather abruptly constricted at base, the angles evident though rounded, the sides from the eyes to the angles feebly converging and but slightly arcuate; prothorax much narrower and shorter than the head, three-fourths as long as the latter, widest near apical third, the sides rounded anteriorly, sinuato-converging posteriorly, the apex and base truncate and densely fringed with porrect fulvous squamules as usual, the surface convex, impressed medially near the base; elytra barely twice as long as wide, twice as wide as the prothorax, arcuately narrowed at base and apex, a little more gradually toward the latter, the sides parallel and feebly arcuate, the bristles becoming yellow and squamiform behind, darker and hair-like elsewhere; intervals between the ridges flat, coarsely, biseriately punctate, with a series of widely spaced setæ between the rows; abdomen sparsely punctate. Length 3.7 mm.; width 1.07 mm. California (Vallecito, — near Julian).

costipennis Lec.

Body small, more slender, dark rufo-piceous in color, the anterior parts rather sparsely squamose, more finely and sparsely and less roughly punctured than in *costipennis;* head rather large, elongate-oval, more gradually narrowed though more or less strongly rounded toward base, the sides scarcely visibly converging from the antennal prominences to the basal arcuation; prothorax relatively narrower and more elongate than in *costipennis*, four-fifths as long as the head and much narrower, much longer than wide, formed nearly as in *costipennis* but relatively less narrowed toward base, more narrowly impressed along the median line almost in basal third; elytra evenly oval, very elongate, distinctly more than twice as long as wide, the bristles abruptly pale and squamiform near the apex, the double series of coarse punctures separated by a widely spaced series of inconspicuous setæ, the costæ nearly as in *costipennis;* abdomen rather coarsely and sparsely but more distinctly punctured, the surface smoother. Length 3.2–3.5 mm.; width 0.77–0.98 mm. Arizona (Tucson), — H. F. Wickham.

tenuis n. sp.

5 — Form slender, the smallest known species of the genus, dark rufo-piceous, the punctures and scales of the anterior parts small and

rather sparse; head large, elongate-oval, smoother and more shining than usual, the sides strongly converging and almost evenly arcuate from the eyes to the neck; prothorax very small, three-fourths as wide as the head and two-thirds as long, elongate, widest near apical third, where the sides are subprominently rounded, thence converging and nearly straight to the base, the truncate base and apex fringed as usual; surface convex, feebly impressed along the median line throughout, very finely in the centre, more broadly toward apex and base; neck two-fifths as wide as the head; elytra less elongate than in *tenuis*, though fully twice as long as wide and more than twice as wide as the prothorax, evenly oval, sculptured nearly as in the two preceding, the spicules of the ridges and serial interspaces similar but, at apex, not quite so evidently squamiform and but little paler; abdomen smooth and polished, moderately coarsely, sparsely punctate. Length 2.9 mm.; width 0.72 mm. California (Palm Springs).....**exiguus** n. sp.

6 — Form rather short, stout and convex, the anterior parts densely, rather roughly punctate, finely, somewhat sparsely squamulose and blackish-brown in color, the hind body pale red-brown; head large, suboblong, widest at the antennal prominences, the sides thence evidently converging and nearly straight to the basal angles, which are evident and not very rounded, the base arcuately subtruncate; eyes well developed, widely divided, the upper lobe of about 21, the lower of 5 coarse facets, the surface canaliculate along the median line in less than basal half; prothorax only slightly narrower but very much shorter than the head, not longer than wide, widest near apical third, where the sides are evenly rounded, thence strongly converging and sinuate to the base; periphery at ends and sides similarly and densely fimbriate with long erect scales; surface with two fine, straight and parallel ridges from apex to base, separated by nearly a third of the width, each of which has a dense erect fringe like that at the sides; elytra oval, not quite twice as long as wide, not quite twice as wide as the prothorax, the parallel sides rather arcuate, the surface with ridges and double series of coarse punctures as in the preceding species, the close, erect and bristling fringe along each ridge pale flavate in color, composed of narrow claviform scales, with their apices bent posteriorly and their posterior edges throughout their length apparently thin, transparent and membranous; a few similar scales are also scattered along the flat intervals between the rows of coarse punctures; abdomen unusually coarsely, very closely punctate and dull. Length 3.6–3.8 mm.; width 1.15 mm. Arizona (Tucson).....**fimbriatus** Csy.

7 — Femora wholly devoid of denticle.....8

Femora with a small acute denticle beneath beyond the middle, except the posterior femora, which are not denticulate.....13

8 — Intervals between the rows of coarse punctures of the intercostal depressions flat and wholly devoid of punctures or squamules...9

Intervals usually somewhat elevated, punctate and bearing squamules similar to those of the ridges..... 12

9 — Pronotum broadly, feebly and subequally sulcate along the middle from apex to base..... ... .10

Pronotum not sulcate, though generally feebly impressed near the base 11

10 — Body moderately slender, the elytra flattened above, dark rufo-piceous in color; head large, much elongated, the sides distinctly converging and feebly arcuate from the antennal prominences to the broadly rounded basal angles, the base extending but little laterally beyond the neck, the surface not sulcate basally; eyes above elongate and narrow, small beneath as usual; prothorax relatively very small, three-fourths as wide and two-thirds as long as the head, widest anteriorly, where the sides are rounded, thence strongly converging and broadly sinuate to the base, the sides fringed with long, close-set, yellow squamules but not the apex, base or dorsal ridges, the surface sparsely squamulose, densely punctate like the head, with two longitudinal obtuse ridges, separated by an impressed sulcus throughout the length; elytra elongate, evenly oval, evidently more than twice as long as wide, the yellowish squamules of the ridges close-set and subdecumbent, the marginal series only present in apical third; abdomen shining, sparsely and not very coarsely punctate. Length 3.6 mm.; width 0.9 mm. California (Inyo Co.)..... .....**sulcicollis** Horn

Body shorter and much broader, the elytra duller, dark castaneous in color throughout; head large but much less elongate, densely punctate, the sides more strongly converging and evenly arcuate from the eyes to the neck, the yellowish squamules distinct, not dense; eyes above much shorter than in *sulcicollis* and with fewer facets, similar beneath; prothorax not as small as in *sulcicollis* and much less elongate, only slightly longer than wide, the lateral fringe similar, the apical squamules rather evident and with others scattered over the low obtuse entire dorsal ridges, the surface densely opaque; elytra oval, depressed, not at all more than twice as long as wide, the sides rounding to the base, straighter and less rapidly converging toward apex, the latter very narrowly obtuse, the yellow squamules along the ridges close-set and rather broad, subdecumbent, the marginal series as in *sulcicollis;* abdomen rather more coarsely but sparsely punctured. Length 3.4–3.5 mm.; width 1.0 mm. Southern California.....**simulans** n sp.

11 — Form moderately slender, the size larger than in the two preceding species, piceous-black, dull or subopaque; head much less elongate, only slightly longer than wide, the sides parallel and straight near the middle, abruptly converging and nearly straight toward base to the neck, densely punctured, with small scattered squamules, the occiput narrowly and deeply canaliculate; eyes above shorter and broader than usual, below nearly rounded, very small, of about four facets; prothorax large, only slightly shorter and narrower

than the head, widest anteriorly, where the sides are evenly rounded, thence moderately converging and sinuate posteriorly, becoming parallel in basal fourth, the sides and the truncate apex and base densely fringed with short pale squamules, convex, coarsely, densely punctate, with the scattered squamules closer near the median line toward base, the surface narrowly and moderately impressed along the median line, except anteriorly; elytra barely twice as long as wide and not quite twice as wide as the prothorax, the sides rather gradually rounding toward base and still more gradually and straighter toward the bluntly rounded apex, parallel and almost straight, the yellowish squamules of the ridges small, the marginal series confined to apical third or fourth; surface moderately convex, the punctures of the regular double series coarse as usual, rather close-set; abdomen smooth, somewhat coarsely and not very sparsely punctate. Length 3.7–4.2 mm.; width 0.85–1.2 mm. Arizona (Tuçson).....**regularis** Horn

Form rather slender, moderately convex, piceous or blackish, rather dull in lustre; head moderately large, evidently longer than wide, the sides from the antennæ to behind the eyes moderately converging and nearly straight, then broadly, evenly rounding and converging to the neck, the surface rather closely punctate and with the usual scattered yellow squamules, the occiput very feebly impressed at base; eyes above narrow, of about 19–20 facets, beneath of 5 facets; prothorax distinctly narrower and shorter than the head, distinctly elongated, widest and narrowly rounded at the sides anteriorly, thence very moderately, subsinuously narrowed to the base, fimbriate about the entire contour, the lateral hairs shorter and thinner than those at the truncate ends; surface convex, even, not very densely punctate, with subevenly scattered squamules, feebly impressed medially toward base; elytra rather more than twice as long as wide and fully twice as wide as the prothorax, the flavate squamules along the ridges and the double series of coarse punctures nearly as in *regularis*, the punctures less close-set in the series as a rule; abdomen similarly punctate, the propleuræ very sparsely. Length 3.8–3.9 mm.; width 1.0 mm. Texas (El Paso).....**simplex** Csy.

12 — Body moderately slender and convex, somewhat as in *regularis*, opaque anteriorly, densely punctured and blackish-castaneous, the elytra more shining and rufescent as usual; head but little longer than wide, parallel and somewhat arcuate at the sides to the broadly rounded basal angles, the base broad, the occiput not impressed; eyes broadly divided as usual, the upper part long and narrow, the lower minute; scattered squamules short but broad; prothorax larger than usual, evidently shorter but only slightly narrower than the head, widest behind apical third, where the sides are subprominently rounded, thence moderately converging and nearly straight to the base, having a dense short fringe of coarse squamules throughout the contour, the surface convex, flattened narrowly along the middle and evidently impressed near the base, where

the squamules, which are rather close throughout, become denser at each side of the middle; elytra barely twice as wide as the prothorax and scarcely twice as long as wide, of the usual oval form, the double series of coarse punctures separated by a scarcely elevated row of squamiferous punctures, the squamules similar to those of the more elevated ridges, though scarcely so close-set; propleuræ only moderately sparsely punctate, the abdomen alutaceous and micro-reticulate, somewhat coarsely, sparsely punctate. Length 3.9 mm.; width 1.1 mm. Arizona (near the southern boundary).....**decipiens** Horn

13 — Form rather stout, moderately convex, rather pale red-brown, the anterior parts darker; head moderately large, a little longer than wide, the sides from the antennæ moderately converging and feebly, evenly arcuate to the basal angles, which are distinct though rounded, the base broadly truncate, the occiput only minutely impressed at the extreme base; surface above and beneath, like that of the prothorax, coarsely and densely punctate and opaque, the fulvous squamules rather dense and conspicuous, particularly close, semi-erect and broadly dense along the longitudinal ridges of the pronotum; eyes longitudinal as usual above, very minute and consisting of three facets beneath; prothorax but little narrower, though distinctly shorter, than the head, as wide as long, widest anteriorly, where the sides are evenly rounded, thence rather strongly converging and nearly straight to the base, the sides with a dense erect fringe which is wanting at apex and base, the yellow squamules very dense in two lateral and two median spots at the base, the surface deeply and obtusely sulcate from base to apex; elytra three-fourths longer than wide, fully twice as wide as the prothorax, oval, the sides strongly and rapidly rounding to the base but much more gradually behind, the ridges acutely and strongly elevated, the two punctured series of the intervals separated by a scarcely elevated line of squamiferous punctures which are almost similar to those of the ridges, the punctures of the series becoming obsolete toward apex; abdomen dull, finely, not very sparsely punctate. Length 3.6–4.0 mm.; width 1.1–1.2 mm. California (Inyo Co.). .....**armatus** Horn

Form still stouter, dull, the elytra but little paler though less dull, red-brown in color; head distinctly longer than wide, the epistoma more anteriorly extended than in *armatus*, the sculpture, squamæ, eyes and basal impression of the occiput similar, the sides more parallel, the angles more broadly rounded and transverse at base to the neck; prothorax very slightly narrower but much shorter than the head, scarcely as long as wide, widest near apical third, with the sides broadly rounded, becoming but feebly converging and very gradually almost straight posteriorly, the dull rugose surface, squamæ, lateral fringe and basal tufts as in *armatus*, the median sulcus similarly entire but narrower and very much more feeble, not marked along the sides by such close-set squamules; elytra rather broader, barely three-fourths longer than wide,

similarly somewhat shouldered, the ridges less elevated and the series of squamiferous punctures, separating the series of coarse punctures, rather more prominent, so that all the series of pale close-set squamæ are more nearly equal in elevation; punctures of the series distinct to the apex, though becoming notably smaller posteriorly; abdomen less dull, rather coarsely, somewhat sparsely punctate; spicule beyond the middle of the under surface of the anterior femora a little larger than that of the intermediate femora as in *armatus*. Length 3.9–4.1 mm.; width 1.18–1.25 mm. Wyoming (Green River), —H. F. Wickham...**duplicatus** n. sp.

Although the coarse punctures of the elytral series generally become materially less coarse toward apex, due to the contraction of the elytra, *armatus* is the only one in which they become obsolete, or nearly so, for a long distance from the apex, this being a very remarkable distinguishing character of that species; the punctures become unusually small, for a much shorter distance from the apex however, in *decipiens* also. *Duplicatus* was confounded with *armatus* by Dr. Horn, though they are strikingly different in many characters, but especially in the relative degree of prominence of the elytral ridges and in the nature of the punctuation posteriorly. In *armatus* the squamæ of the intermediate lines appear to be less securely attached than those of the principal ridges, and I have one specimen in which they have become entirely removed, except in a portion of one line, while those of the prominent ridges are undisturbed; the tuberculiform punctures bearing them can always be easily observed, however, so that this character can be verified with a little care in observation.

Tribe Dacoderini.

While widely removed from any other, this tribe betrays an affinity with the Araeoschizini, and particularly the Adelostomini, in the antennæ, which are similarly stout, cylindric and perfoliate, differing from the first only in having the eleventh joint still more deeply sunken within the tip of the tenth, though perfectly visible from an oblique anterior view, thus proving that the antennæ are really 11-jointed and not 10-jointed as generally stated. In the Adelostomini the eleventh joint has sunken still deeper within the capacious apex of the tenth joint, in such manner as to have entirely disappeared, leaving only its

wide flat sensitive apex to form the floor of the shallow excavation. In *Adelostoma*, therefore, the antennæ are only apparently 10-jointed but might be so considered, in view of the complete disappearance of the eleventh within the tenth, a process of withdrawal begun in *Araeoschizus* and carried still further in *Dacoderus*. The emarginate clypeus may also recall the two genera mentioned, and the large mentum, wholly covering the maxillæ and emarginate at apex, is somewhat similar to that of *Adelostoma*. The excavated abdominal sutures and slight transverse fossa of the last segment, suggest some relationship with the Usechini, and the well-defined epipleuræ, some alliance with Stenosini, but the *Clinidium*-like body, remarkable cephalic and pronotal fossæ and contiguous anterior coxæ, are special characters that widely isolate the tribe from any other living type at present known. The single genus may be rather fully described as follows: —

Body slender, depressed, glabrous; head deeply and abruptly constricted at base, broadly produced and subquadrate before the eyes, the antennal prominences large and convex, the front deeply excavated anteriorly between the prominences, the anterior wall of the excavation deeply cleft at the middle, giving communication with a large deep excavation in the rather small, transverse and deflexed clypeus, the two strongly elevated lateral lobes of which, thus formed, are flattened, ciliate on their inner edges and finely punctate; this clypeus is separated from the front by a transverse suture; labrum small, transverse, emarginate and exposed; mandibles small, slender toward tip, canaliculate beneath and bifid; mentum large, transverse, semi-circularly rounded posteriorly, exactly fitting the semi-circular buccal opening and concealing the maxillæ, subtransverse at apex though with a small deep median emargination, the ligula large, broad, densely chitinized and sculptured, obtriangular, the palpi slender, the last joint of the maxillary elongate-oval, obtusely and obliquely pointed at tip; eyes near the base of the head, coarsely faceted, elongate, not divided, situated at the middle of the vertical sides of the head, on a bracket formed by an extension of the under surface and but slightly inclined in plane, giving no downward vision whatever; neck rather narrow, abruptly constricted; antennæ stout, with transverse and submoniliform, perfoliate joints, sparsely setose, the ninth and tenth joints a little larger, the third as long as wide; prothorax elongate, suboval, crossed near basal third by a broad and very deep sulcus, which is closed at each side by an irregularly bulbiform part of the general surface, the median line deeply canaliculate throughout, the canaliculation crossing the

transverse sulcus; line of demarkation between the pronotum and propleuræ impressed throughout; prosternum very long before the coxæ and transversely impressed at about the middle; scutellum minute but evident, elongate-oval; elytra not margined at base, not costate but with a flat sutural elevation, feebly embracing the sides of the body, the epipleuræ narrow though entire and with a continuous flat raised line at their lower margin; abdominal sutures perfectly rectilinear throughout, deep and sulciform, the fifth segment very short, transversely impressed somewhat as in *Usechus*, the first segment very long; coxæ small, the anterior contiguous, the middle narrowly, the posterior rather widely, separated; metasternum long though shorter than the first ventral, the episterna very narrow, linear; legs rather short, moderately stout, the tibial spurs short but distinct, the hind tarsi stout, cylindric, much shorter than the tibiæ, sparsely spinulo-setose beneath, the first joint much shorter than the next two combined, the claws small and slender. [Type *D. striaticeps* Lec.].....**Dacoderus**

I only know this genus from the Sonoran fauna of our extreme southwest, though it is said to occur also in the West Indies, but, if the latter form, described under the name *dominicensis* by Horn, is truly endemic, it is probably not strictly congeneric, although doubtless assignable to the same tribe.

Dacoderus Lec.

The contiguous anterior coxæ of this genus constitute an exception in the entire family Tenebrionidæ, so that its general isolation can be well appreciated, although there are some characters, as above defined, that conclusively prove its general position to be in the series of small slender forms allied to *Arœoschizus*, *Adelostoma* and *Stenosis*. The transverse sulcus of the pronotum, traceable also as a depression of the prosternum, is remindful of some Histerids; it is a singular repetition, in the second segment of the body, of the sulcus and tuberosities of the first segment or head, the frontal modifications of which are without a parallel known to me. Our single species is the following:—

Body very elongate, parallel, slender and depressed, polished, glabrous, the anterior parts with very few short sparse hairs, dark castaneous in color; head longer than wide, dilated and laterally oculate in basal half, the surface above longitudinally and coarsely plicate, flat, gradually declivous anteriorly to the frontal excavation, canaliculate beneath along the median line, the antennæ not quite as long as the head and prothorax, the latter elongate, evidently longer than

the head but not quite as wide, widest near the apex, where the sides are strongly rounded to the very briefly tubulate and truncate apex, gradually converging to the broadly arcuate base, which is much wider than the apex, the sides prominent at the bulbiform ends of the sulcus, the surface longitudinally plicate except toward the sides, where it becomes sparsely and simply punctate; elytra at least one-half longer than the anterior parts, more than two and one-half times as long as wide and fully three-fourths wider than the prothorax, circularly emarginate at base, the sides feebly arcuate, gradually and feebly converging from before the middle to the rapidly and obtusely rounded apex, broadly rounding at base to the humeral angles, which are not rounded and somewhat exposed, the surface flat above, rather abruptly almost vertical at the sides, broadly, flatly and feebly elevated at each side of the suture, these flat surfaces each with an even medial series of fine punctures, the general surface with coarse and elongate, moderately close punctures, becoming gradually finer posteriorly; abdomen feebly convex, finely, sparsely punctate medially, coarsely and closely toward the sides and on the last two segments. Length 3.9–4.2 mm.; width 0.9–0.95 mm. Arizona (Tuçson), — H. F. Wickham ..... **striaticeps** Lec.

This species occurs under stones in hot dry places, from southern California to southeastern Arizona, and, according to Dr. Horn, feigns death very persistently when disturbed; it is probably more for this reason that it is seldom taken, than because of its actual rarity. The elytral punctures are confused, but form also two feebly defined irregular discal series, evanescent posteriorly on each elytron.

Tribe Typhlusechini.

A singularly isolated minute species necessitates another special tribal group under the above name. The large convex clypeus, broadly sinuate at tip and concealing all the mouth parts from above, and the convex abdomen, with large and unmodified fifth segment and strongly sinuate third suture, certainly indicate an alliance with the Araeoschizini, but the antennæ are wholly different, and the reception of the antennæ in long deep cephalic grooves ending in the anterior part of the propleuræ, is a character wholly without parallel in the subfamily. The type species approaches the completely blind condition more closely than any other Tenebrionid that can be called to mind at present. The genus may be described as follows: —

Body parallel, evenly and moderately convex, feebly sculptured; head quadrate, parallel, not in the least narrowed at base, the surface evenly convex toward the sides and apex, the antennal tuberosities large and very feeble, the oblique sutures fine and long, the clypeus convexly declivous anteriorly, with its apex broadly sinuate and its apical edge thinner, translucent and subcoriaceous; mandibles small, bifid at tip; mentum moderate, subquadrate, parallel, wider than long, exposing most of the maxillæ at the sides but concealing the narrow ligula, its apex transversely bisinuate; palpi slender, the last joint of the maxillary narrow, elongate-oval, circularly and minutely truncate at tip, longer than the two preceding combined; eyes extremely minute, on the upper surface near the base and at some distance from the obtuse sides of the head, consisting of a slender oblique slit, closed at the middle by the intrusion of its sides, the anterior part very small, rounded and enclosing a very few extremely minute crystalline facets, the posterior part elongate, lenticular and extremely minute with the facets not distinct; antennæ rather slender, compact, cylindric, as long as the head, 11-jointed, the two basal joints a little thicker, outer joints of the funicle increasing very slightly in width, the last three joints broader, forming a loose and subcompressed club, the last joint very much longer than the preceding but barely as wide and obtusely rounded at tip, the fossæ narrow and very deep, rectilinear, approaching the sides of the head behind and continuing onto the anterior part of the propleuræ, where they become larger and deep but less sharply defined; prothorax obtrapezoidal, thickly beaded at the sides, with a short strong carina at each side of the middle at base, near outer fourth; scutellum triangular, confined to the sloping base of the elytra, the latter each with a thick basal margin externally, arcuately, internally receding from the base, to inner third, where it continues posteriorly as an excessively minute raised line not quite to the apex; there are also three other partial raised threads on each elytron, the side margins at the epipleuræ conspicuously concave and with a series of large impressed foveæ; median part of the elytral base convexly declivous anteriorly, the elytra moderately embracing the body at the sides, the inflexed part occupied wholly by the wide, flat and entire epipleuræ, which are margined beneath by a narrow flat raised line; prosternum long before the coxæ, the metasternum long, very much longer than the first ventral, the episterna moderately narrow, increasing in width posteriorly, the suture straight and very feeble; abdomen convex, the last three segments more tumid at the sides and intruding somewhat upon the epipleuræ, the sutures fine, straight, the third broadly sinuate, becoming transverse laterally; coxæ very small, the anterior rather narrowly, the posterior very widely, separated; legs short, moderately stout, the tibiæ increasing in width from base to apex, without terminal spurs, the tarsi short, cylindric, compact, with a few short setiform spines beneath, the first three joints of the posterior sub-

equal in length and together but little longer than the fourth, which is bent downward toward tip, the claws very small, rapidly aciculate and feebly arcuate. [Type *T. singularis* Lin.].
Typhlusechus

The above description is very detailed and will probably serve for comparison with related genera, in any direction, however unsuspected at present. Linell places this tribe in the Asidinæ, but it has so much affinity with the tribes here discussed, that I prefer to treat it with them, and moreover, there appears to be no trochantin attached to the middle coxæ.

Typhlusechus Linell.

It is probable that the minute species of this genus occur in very secluded stations, under deeply imbedded stones or possibly with ants; the original notes of Mr. Linell are not before me at present. The cotype here described was very kindly given me by Mr. Chas. Fuchs, of San Francisco, some years ago; its chief specific characters are as follows: —

Form moderately slender, parallel, evenly and transversely but moderately convex, rather shining, glabrous, dark testaceous in color; head quadrate, finely, rather closely punctate, the sides somewhat abruptly oblique and straight anteriorly to the broadly sinuate apex; prothorax large, conspicuously wider and very much longer than the head, scarcely longer than wide, widest very near the apex, where the sides are rather prominently rounded, thence at first slightly sinuate and then nearly straight and feebly, evenly converging to the base, the apex sinuato-truncate, distinctly wider than the broadly arcuate base, the surface finely, somewhat closely punctate, with an entire smooth and impunctate line, the concavity along the thick reflexed lateral beaded edge with a row of coarser punctures anteriorly; elytra equal in width to the prothorax and three-fifths longer, about three-fifths longer than wide, the sides parallel and straight, rounding slightly at base to the rather prominent humeral angles, obtusely parabolic at tip, the surface extremely minutely, somewhat sparsely punctate, the suture very fine and simple; abdomen rather finely, somewhat sparsely punctate, becoming extremely minutely and sparsely so toward tip, the last ventral circularly rounded and almost as long as the two preceding combined. Length 1.7 mm.; width 0.48 mm. California (Los Angeles Co.).....**singularis** Linell

There are many singular characters pertaining to this very minute Tenebrionid, besides the eyes, antennæ and intrusion of the sides of the abdomen upon the epipleuræ posteriorly, —

for example the posteriorly flexed basal margins of the elytra, becoming the innermost of the fine discal threads of the dorsal surface, and the fact that the abdomen becomes more minutely and sparsely punctate posteriorly, instead of more densely as is the general rule. No sexual marks can be perceived in the specimen before me.

Tribe Batuliini

In *Batuliodes*, provisionally assigned to this tribe, the antennæ are as in *Typhlusechus*, only much more elongate and are perfectly free, not being received in grooves, and there seems to be a premonition of the trochantin becoming so distinct in *Anepsius*, the sterna coming together at a very large deep suture, which is much more open near the coxæ than in any of the preceding tribes. The body is very small in size, oblong-oval and not linear or with the hind body dilated as in the Dacoderini or Araeoschizini, but resembling *Anepsius* completely. The two genera may be described as follows[1]: —

Body larger, sparsely pubescent; prothorax not so basally narrowed; eyes not at all divided; clypeus not emarginate anteriorly; antennæ short, apically incrassate; mentum and palpi nearly as in the preceding; anterior tibiæ strongly dilated, subdentate externally. [Type *B. setosus* Lec.].....**Batulius**

Body oblong-oval, evenly and moderately convex, glabrous; head trapezoidal, transverse, scarcely constricted at base, the clypeus large, transverse, virtually concealing all the month-parts from above, the apex broadly emarginate, the bottom of the emargination broadly arcuate, the lateral lobes somewhat advanced, prominent and narrowly rounded, the lateral sutures short and feeble, the supra-antennal prominences very feeble; mandibles small, slender, bifid at tip; mentum moderate, subquadrate, obliquely narrowed toward base, exposing the entire maxillæ but covering the short broad ligula, the palpi small, moderately slender, the last joint of the maxillary narrowly oval, obtusely pointed, longer than the preceding; eyes basal, moderately large, on the sloping sides and giving no vision directly beneath, coarsely faceted, completely divided by the anterior canthus, which extends to their transverse hind margin, both segments narrow, elongate and deeply sunken, the inner segment bounded internally by a very short and feeble ridge, the outer externally by the slightly extended under surface; antennæ moderately long, slender, subglabrous

[1] The characters of the tribe Batuliini, given on page 282 of this paper, are taken from *Batuliodes rotundicollis*, and may not therefore be truly those of the tribe as represented by its proper type, which is *Batulius setosus* Lec.

and shining, the joints narrowing but little toward their bases, one to seven elongate, the first a little thicker than the following, the second much elongated, two to seven equal in diameter but diminishing in length, eight to eleven forming a broader, elongate, loose and compressed club, the eleventh longer than wide, ogival, evidently longer but somewhat narrower than the tenth; prothorax obtrapezoidal, with rounded sides; scutellum large, transversely triangular but confined entirely to the broad peduncle at the base of the elytra, the latter not margined at base, with series of punctures, moderately embracing the sides of the body, the inflexed sides occupied by rather narrow and entire epipleuræ, which have a broad flat elevated lower edge throughout; prosternum rather short before the coxæ, the intercoxal process subhorizontally extended behind them for a short distance, angulate and prominent at apex; metasternum large, the episterna moderately wide, parallel, the suture distinct and rectilinear; abdomen evenly and moderately convex, the first three segments large, diminishing in length, the fourth very short, the fifth rounded behind and unmodified, nearly as long as the third, the sutures equally and feebly curved and rather fine, the second to fourth abruptly bent posteriorly for a short distance at the extreme sides; coxæ moderate, the anterior moderately separated, the intermediate rather narrowly, the posterior obliquely sublinear, transverse and somewhat widely separated; legs short but not very stout, subglabrous, the tibiæ rather abruptly dilated at apex, with evident spurs. [Type *Batulius rotundicollis* Lec.].....**Batuliodes**

LeConte described two species under the generic name *Batulius*, the first only of which, published under the name *setosus*, appears to have been examined in regard to its generic characters. Making all due allowance for mistakes of observation, the characters above given for *setosus* differ profoundly enough from those of *rotundicollis* to demand generic separation. Neither of these species seems to have been given more than the most cursory examination since the original descriptions were published in the Annals of the New York Lyceum (V, p. 148), and, as I do not have any representative of *setosus* before me, I am compelled to transcribe the above superficial and unconfirmed generic characters.

Batulius Lec.

I have to regret my inability to give a more extended account of this interesting genus at the present time, and shall have to limit my recount of characters to those already published. If the eyes are correctly described by LeConte—"occuli haud

divisi."—the generic difference between *Batulius* and *Batuliodes* would be extremely radical on that account alone, but the form of the anterior margin of the clypeus, as described by that author, is probably correct, being more easily observed under low power, and even this would amply suffice for generic distinction, irrespective of the different form of the prothorax and the sparse erect pubescence. We have but a single species as follows: —

Form oblong, convex, pale rufous in color, shining, sparsely pilose; prothorax more than twice as wide as long, muricately punctate, densely at the sides, the latter strongly rounded, the apex emarginate, the base truncate, the angles obtuse; elytra with less approximate punctures, subseriately disposed. Length 3.5 mm. Southern California (Vallecito and Gila) .....**setosus** Lec.

Both this species and *rotundicollis* appear to be very rare, or at least seldom taken; possibly they may feign death and their pale coloration would then render them difficult to distinguish.

Batuliodes n. gen.

The generic diagnosis above given is derived from a single rather delapidated individual, without legs, save the femur and tibia of one of the intermediate pair, so that I have been unable to describe the tarsi. These are said by Horn (Rev. Ten., p. 270), to be short and spinose beneath, probably in *setosus*, but without much doubt somewhat similar in the following type species of *Batuliodes*, which may be thus briefly outlined: —

Body minute, evenly convex, polished, glabrous, pale brownish-testaceous in color throughout; head transverse, moderate, evenly and feebly convex, rather coarsely, closely and roughly punctate, each puncture attended by a feeble external carina; antennæ slender, almost as long as the head and prothorax, the latter four-fifths wider than long, very much wider and a little longer than the head, the sides rather strongly arcuate, more converging and less arcuate toward base, the latter truncate and much narrower than the apex, which is broadly, feebly sinuate, the side margins acute, the surface rather coarsely, sparsely and simply perforato-punctate and polished, abruptly more densely and confluently so near the sides; elytra equal in width to the prothorax and two and three-fourths times as long, oval, the sides evenly arcuate, strongly and evenly rounding at base to the transversely truncate base of the elytra, which is laterally exposed beyond the very obtuse thoracic angles, the apex obtusely parabolic; surface with regular, unimpressed series of small, not very close-set

punctures, each puncture attended anteriorly by a fine carina extending almost to the next puncture; abdomen rather strongly but sparsely punctured. Length 2.3 mm.; width 0.68 mm. Southern California.....**rotundicollis** Lec.

The carinæ attending the elytral punctures are almost exactly as in *Anepsius*, and it is certain that these two genera should not be widely separated.

We have now concluded all the tribes placed in the subfamily Tentyriinæ by LeConte and Horn, by reason of lacking the coriaceous hind margin of the subapical ventral segments and absence of the trochantin of the intermediate coxæ, but, as before remarked under the tribe Zopherini, it is much more than probable to my mind, that we should divide LeConte and Horn's first two subfamilies in a different way, limiting the Tentyriinæ solely to those forms with a very large mentum. Then we have another subfamily, including all the tribes from Zopherini to, but not including, the Asidini of Horn, disregarding the trochantin but associating together genera that very evidently resemble each other in general habitus; then, in succession, the Asidinæ, limited to the tribe Asidini of Horn, and finally the Coniontinæ, an isolated subfamily group, comprising the tribes Coniontini, Praocini, Branchini and Cœlini, the genera *Cœlus* and *Cœlomorpha*, composing the last named, not being properly tribal associates of *Coniontis* and *Eusattus*. This is by no means a finality of conclusion, simply occurring to me as a suggestion, but on the strength of this habital resemblance, I will include in the present paper the five following genera, having a distinct trochantin interposed between the sterna which enclose the middle coxæ externally: —

Body nearly as in *Batuliodes* but larger and stouter, convex, glabrous; head similarly trapezoidal but with the clypeus very broadly and feebly sinuate toward the middle and less completely covering the mouth-parts, the sides not anteriorly prominent; eyes basal, more rounded and less coarsely faceted, generally completely divided in a similar manner by the thick anterior canthus, which similarly attains the transverse basal line of the eye, the lower part wholly inferior and much smaller than the upper part; antennæ, mandibles, mentum and palpi similar, except that the antennæ are shorter, with the third joint longer than the second; prothorax and elytra similar, the intercoxal process of the prosternum similarly

projecting subhorizontally backward, the metasternum much shorter, with broader episterna, the abdomen subsimilar, except that the sutures are not bent backward at the sides;[1] legs rather short, moderately slender, the anterior tibiæ very broadly dilated externally at apex, with the spurs distinct and very unequal in thickness; tarsi short, sparsely spinose beneath. [Type *A. delicatulus* Lec.] ..... **Anepsius**

Body much more elongate and still larger, slightly convex, glabrous; head smaller, subquadrate, obliquely narrowed in anterior half, the clypeus transversely truncate with rounded angles, almost covering the mouth-parts, the antennal prominences feeble but rounding inward posteriorly to the eyes, which are large, convex, somewhat prominent, subbasal, transverse, on the sides of the head and only feebly and broadly sinuate anteriorly; mentum rather small, subquadrate, parallel, truncate, exposing all the maxillæ and most of the ligula, the palpi rather long and slender, the last joint of the maxillary elongate and obliquely truncate; mandibles slender, bifid at tip; antennæ very long, slender and filiform, with sparse hairs, the outer joints not at all wider but becoming shorter, the eleventh with a conoidal sensitive apical process, the third joint most elongate, the basal much the stoutest, the remaining ten joints exactly equal in width; prothorax sharply margined at the sides, the apex and base subtruncate, the latter very feebly arcuate toward the middle; scutellum large, transverse, truncate and conspicuous; elytra confusedly punctate, with narrowly reflexed and acute margin, the epipleuræ rather wide, flat, entire, occupying the entire inflexed side, with the raised flat lower margin very narrow; prosternum moderately separating the coxæ, not much produced and narrowly rounded posteriorly, somewhat free as in *Anepsius;* middle coxæ with distinct trochantin; metasternum large, fully as long as the first ventral, the episterna moderately wide, the suture rectilinear, gradually approaching the sides posteriorly; abdomen nearly as in *Anepsius*, except that the fourth segment is similar to the third and but little shorter; legs and tarsi rather long and slender, the anterior tibiæ linear, not dilated apically, the spurs small but distinct, subequal, the tarsi with very short sparse spinules beneath. [Type *V. tenuicornis* n. sp.]. **Vacronus**

Body elongate, parallel, convex, the integuments harder and denser, the size much larger, subglabrous; head not wider than long, obliquely narrowed from behind the middle to the apex, the latter truncate, with the sides minutely anteriorly prominent, the clypeus not quite concealing the mouth-parts, the mandibles bifid at tip; mentum rather small, tranversely oval, sinuato-truncate at tip, exposing the maxillæ but covering the ligula, the four palpi somewhat slender and elongate, the last joint elongate, obtriangular,

[1] This singular abdominal peculiarity of *Batuliodes* foretells a somewhat general character among the true Asidids.

with the truncate apex filled with whitish spongiose sensitive tissue; side-pieces of the oral cavity prolonged and acutely prominent; antennæ thick, cylindrical, rather long and coarsely sculptured, the outer joints but little wider, the eleventh with a large and obtuse spongiose apical convexity, the second joint short, third and fourth subequal, moderately elongate; eyes rather small, coarsely faceted, transversely reniform; prothorax with acute reflexed side margins: scutellum short but distinct, strongly transverse, truncate; elytra with short costæ forming series, the epipleuræ entire, moderately narrow, occupying the entire inflexed sides; prosternum long before the coxæ, the process slightly prolonged and obtusely porrect posteriorly, the mesosternum not at all excavated, narrow between the coxæ; metasternum well developed, the episterna parallel, moderately wide, the suture rectilinear; abdomen with the segments diminishing slightly in length posteriorly, nearly as in the preceding genus; legs moderately long and stout, the tibiæ not much dilated apically, with the spurs stout and unequal, the tarsi well developed, stout, with long and dense recumbent fulvous hairs beneath, the basal joint of the posterior scarcely as long as the last, the claws long, stout and strongly arcuate. [Type *N. cristata* Esch.]..... ....**Nyctoporis**

Body still much larger and much stouter, moderately convex, glabrous, with very thick dense integuments; generic characters nearly as in *Nyctoporis*, except that the eyes are relatively more finely faceted, the third antennal joint very much longer and the outer joints more dilated, the eleventh almost as wide as the tenth, broadly rounded at base, the spongiose apical part strongly angulate, the glabrous basal part arcuately advancing anteriorly at the sides; intercoxal process of the prosternum broader, flat, acutely porrect behind, the mesosternum elevated and flattened between the coxæ, its anterior wall vertical and excavated for the tip of the prosternal process, recalling *Epitragus;* metasternum extremely short, the episterna moderately wide, narrowing posteriorly, with the suture arcuate; abdomen nearly as in the preceding genus, except that the last three segments are relatively smaller: elytra much more widely embracing the sides of the body, with the epipleuræ narrow, more or less feebly defined; legs long and rather slender, cylindric, the tibial spurs moderate, unequal, the tarsi cylindric, feebly grooved beneath, the joints crowned at apex, and especially at the inferior apices, with short stout fulvous spinules; claws rather small, slender. [Type *C. caraboides* Mann.]. **Centrioptera**

Body very similar to the last but still stouter and more convex, the generic characters almost similar, except that the last antennal joint is relatively very much smaller than the tenth and of a peculiar short, very transverse, obtrapezoidal form, with truncate and sensitive apex, the mesosternal excavation larger and deeper, the elytral epipleuræ more strongly defined and the tarsi even more

feebly channeled beneath, the palpi similar but smaller, narrower and less widely truncate at apex than in *Nyctoporis*. [Type *C. bicostata* Sol.]..... .....**Cryptoglossa**

These genera bring us to the Asidini, of LeConte and Horn, a group very varied, containing species generally rather large in size and of a distinctly different habitus, including many genera, which appear to be less definitely limited than usual.

Anepsius Lec.

There can be no doubt whatever that this genus is to be associated with the Batuliini, as represented by *Batuliodes rotundicollis*, or possibly that *Batulius* and *Batuliodes* should form part of the Anepsiini, without even the distinction of a special group or subtribe, the trochantin losing all of any importance that it may have been supposed to possess in other parts of the series. At the same time, the special form of the eyes, clypeus and elytral vestiture, as stated by LeConte in describing *Batulius setosus*, may indicate that the tribe Batuliini should be composed of that species alone, in which event a tribe Anepsiini would be necessary for *Batuliodes rotundicollis* and the various species of *Anepsius*. It is interesting, in this connection, to trace the development of the peculiar elytral sculpture first observable in *Batuliodes rotundicollis*, where, as stated, each of the elytral punctures is situated at the posterior end of a short linear carinule. This identical structure prevails in the present genus, the carinæ becoming a little stronger, while in *Nyctoporis* they become so strong as to constitute the most conspicuous feature of the sculpture, the series of short carinæ forming strongly marked ridges. In *Vacronus*, a very aberrant type, the elytral punctures become fine and confused but, under sufficient power, the carinæ attached to the punctures may still be observed, though small and feeble and of somewhat different nature. The species of *Anepsius* are rather numerous, those before me being definable as follows:—

Eyes completely divided..... 2

Eyes not quite divided, the canthus approaching closely to the hind margin of the eye but not interrupting the facets.....10

2 — Body uniform in coloration throughout or virtually so, pale brownish-piceous to black..... 3

Body pale brownish-testaceous in color, the disk of the pronotum and a broad subsutural longitudinal streak on each elytron nubilously piceous-black 8

Body bicolored, the anterior parts obscure but pale testaceous, the hind body piceous-black, the abdomen testaceous toward the sides and apex..... 9

3 — Anterior angles of the prothorax blunt.....4

Anterior angles right and not at all blunt, sharply defined 7

4 — Apical angles of the prothorax much deflexed and rounded. Body rather stout and the largest of the genus, convex, polished, glabrous, black, the anterior parts scarcely visibly picescent, the legs and antennæ piceous; head trapezoidal, the oblique sides straight, slightly prominent and arcuate just above the antennæ, the upper section of the eyes rather short, oblong and rather less coarsely faceted than usual, the surface not very coarsely but asperately, somewhat closely punctured; prothorax fully four-fifths wider than long, parallel, the sides evenly and strongly arcuate, the basal angles evident but very obtuse; surface convex, unusually declivous at the sides, finely, rather sparsely punctured, becoming gradually less finely and asperately so laterally but still not very closely; elytra barely one-half longer than wide, gradually ogival behind, the sides parallel, evenly and moderately arcuate to the obtusely but distinctly angulate humeri, which are moderately exposed at base, the disk slightly wider than the prothorax and between two and three times as long, not very closely, finely punctured in close-set series, rather regular laterally but uneven toward the suture, the carinæ attending the punctures laterally extremely small and scarcely noticeable; abdomen finely, very sparsely punctate, more coarsely, closely and rugosely so near the sides. Length 4.5 mm.; width 1.7 mm. Arizona (Holbrook), — H. F. Wickham.....**valens** n. sp.

Apical angles of the prothorax not unusually deflexed or rounded, distinct and merely blunt at the immediate angle..... 5

5 — Elytral punctures laterally not attended by a distinct longitudinal carinule; body unusually short. Form stout, strongly convex, polished, colored as in *valens*, glabrous; head trapezoidal but without the arcuate prominence at the sides above the antennæ, the eyes moderate, coarsely faceted, the surface not very coarsely or closely but very asperately punctate; antennæ a little shorter and stouter than usual; prothorax not quite four-fifths wider than long, three-fourths wider than the head, the base slightly narrower than the apex, the sides moderately and almost evenly arcuate, becoming feebly sinuate at the obtuse but distinct basal angles, which are thereby rendered somewhat prominent, the apical angles bluntly rounded; surface minutely and very remotely punctured medially, then somewhat coarsely and less sparsely, then rather abruptly coarsely, closely and subrugosely near the sides; elytra very short, scarcely a third longer than wide, barely

wider than the prothorax and two and one-half times as long, rather abruptly and broadly ogival behind, the sides parallel and very feebly arcuate to the distinct and angulate humeri, which are only a little exposed at base, the surface very convex and highly polished, with close-set series of punctures laterally, the punctures coarser than usual, not very close-set in the series and without attendant carinules, each with a very minute spiculiform prominence at its anterior edge, not quite so coarse, sparse and almost wholly confused toward the suture; abdomen finely, very sparsely punctured, somewhat coarsely but not densely or rugosely near the sides. Length 3.2 mm.; width 1.2 mm. Colorado (Greeley). **montanus** Csy.

Elytral punctures laterally each at the posterior end of a distinct longitudinal carinule extending almost to the next anterior puncture; body more elongate in form and less convex, less strongly shining.....6

6 — Form moderately stout and convex, somewhat shining, black, the head anteriorly and the elytra effusedly picescent; antennæ piceous, the legs rufous; head evenly trapezoidal, not coarsely but closely and very asperately punctate, the upper lobe of the eyes larger, elongate and subparallel; prothorax less transverse, scarcely more than one-half wider than long, two-thirds wider than the head, widest at the middle, the sides broadly rounded, more converging and straight basally, the base distinctly narrower than the apex, the angles very obtuse but not at all blunt, the apical projecting but little anteriorly and bluntly rounded; punctures fine, perforate and close-set, with a narrow smooth line medially, becoming less fine, rugulose, closer and longitudinally confluent laterally; elytra one-half longer than wide, a little wider than the prothorax and two and three-fourths times as long, oval, gradually but very obtusely ogival posteriorly, the sides distinctly and evenly arcuate to the obtuse and evidently rounded humeri, the punctures fine, in close-set even series throughout, the carinules obsolete toward the suture, the alternate series toward the sides very feebly elevated; abdomen shining, rather coarsely but not very closely punctured. Length 3.7 mm.; width 1.25 mm. California (southern) .... **catenulosus** n. sp.

Form still less stout, moderately convex, piceous-brown throughout, glabrous, shining; head nearly as in the preceding but smaller and less densely, though otherwise similarly, punctato-asperate, the eyes much smaller, the upper lobe short and subtriangular in form; prothorax shorter, three-fourths wider than long, finely but deeply, rather less closely punctured medially, with an irregular smooth line, only a little larger and closer but asperulate laterally, in outline nearly as in *catenulosus*, except that the sides are less converging posteriorly and slightly arcuate and not straight; elytra nearly similar but narrower and somewhat more elongate, not at all wider than the prothorax, more acutely ogival at tip and with

the humeri obtuse but angular and distinct, the sculpture similar though rather finer, the alternate series toward the sides not prominent; abdomen more finely and sparsely punctured medially but as coarsely so laterally; elytral base exactly equal in width to the base of the prothorax, rectilinear and transverse beyond the peduncle, sinuate and convexly sloping medially as usual. Length 3.8 mm.; width 1.2 mm. California (San Diego to Vallecito).

delicatulus Lec.

Form somewhat similar but shorter and rather more convex, shining, black, the legs rufo-piceous; head and eyes nearly similar, the antennæ a little shorter and stouter; prothorax narrower and less transverse, two-thirds wider than long, nearly similar in form and in its even deep apical sinuation, the apical angles a little less blunt, the punctures throughout similarly close-set but rather stronger; elytra decidedly shorter and more rapidly and obtusely ogival at apex, somewhat wider than the prothorax and barely two and one-half times as long, the sides parallel, evenly and moderately arcuate to the humeri, the latter and base of the elytra as in *delicatulus;* sculpture almost similar though rather less fine and somewhat sparser, the alternate series distinctly prominent laterally; abdomen deep black, pale at tip, finely, sparsely punctate medially. Length 3.6 mm.; width 1.2 mm. California (San Diego).

atratus n. sp.

7 — Form nearly as in *delicatulus*, somewhat less shining, dark piceous-brown in color; head nearly as in *delicatulus* but a little larger, more strongly and closely asperato-punctate and with the upper lobe of the eyes a little larger, more elongate and less triangular; prothorax less transverse, one-half to three-fifths wider than long, the anterior angles more anteriorly prominent as well as not blunt, otherwise nearly similar in form and sculpture; elytra rather more obtusely ogival posteriorly and a little wider than the prothorax, otherwise similar throughout to those of *delicatulus*, except that the sides are somewhat less arcuate; abdomen very finely, sparsely punctured medially, moderately coarsely and closely so laterally, especially toward base. Length 3.2–3.9 mm.; width 1.08–1.3 mm. Utah (southwestern), — C. J. Weidt.

brunneus n. sp.

8 — Body more slender, moderately convex and shining, glabrous as usual; head nearly as in *delicatulus* throughout, the eyes a little more elongate; prothorax relatively much broader, barely two-thirds wider than long, subparallel, the sides subevenly and somewhat strongly arcuate, only a little more converging basally, the base only just visibly narrower than the apex, with the angles very obtuse but distinct, the apical angles right and blunt, the apex evenly and distinctly sinuate between them; surface rather finely and closely punctured medially, with the smooth line indistinct, larger, dense and rugulose laterally; elytra one-half longer than wide, distinctly narrower than the prothorax and barely two and

one-half times as long, gradually and arcuately narrowed to the narrowly obtuse tip in apical two-fifths, the sides parallel and evenly, moderately arcuate to the obtuse and subangulate but bluntly rounded humeri, the basal line thence to the peduncle somewhat oblique; surface with fine serial sculpture as in *delicatulus*, the alternate series subelevated laterally; abdomen finely, sparsely punctured medially. Length 3.0 mm.; width 1.1 mm. California (southern).....**nebulosus** n. sp.

9 — Body formed nearly as in *nebulosus* and, similarly, only moderately shining; head a little larger and more broadly truncate at apex than in *nebulosus*, similarly sculptured, the eyes similar, the upper lobe elongate, the antennæ rather stouter; prothorax relatively rather broad, nearly three-fourths wider than long, the sides broadly and moderately arcuate, more converging toward base than in the preceding, the basal angles similar, the apical less anteriorly prominent and still more blunt, the apex evenly sinuate; surface strongly, moderately closely and not so finely punctate medially, with the narrow median smooth line better defined, coarser, moderately dense and subrugose laterally; elytra nearly as in *nebulosus* but equal in width to the prothorax and somewhat more abruptly, obtusely ogival posteriorly, the sculpture almost similar; abdomen finely but strongly, sparsely punctured medially. Length 3.2 mm.; width 1.1 mm. California (Kern Co.).
bicolor n. sp.

10 — Form nearly as in the preceding but still smaller in size, blackish-piceous, the legs rufous, moderately convex, rather shining; head small, of the usual form, the asperate punctures moderately close; prothorax one-half wider than long, the sides moderately arcuate, straighter toward apex and base, more strongly converging toward the latter, the former almost truncate, the angles but slightly prominent and blunt, the basal angles very obtuse though distinct; surface with fine and rather sparse punctures medially, with a narrow smooth line, but little larger or closer but more asperate laterally; elytra equal in width to the prothorax and barely one-half longer than wide, obtusely ogival behind, the sides parallel and feebly arcuate to the obtusely angulate but blunt humeri, the sculpture nearly as in *delicatulus* though rather finer, the alternate series slightly prominent laterally; abdomen somewhat finely, sparsely punctured, coarsely and more closely so laterally. Length 2.75 mm.; width 0.9 mm. California (near San Diego).
deficiens n. sp.

The scutellum is confined to the depressed part of the elytral base, forming part of the peduncle as in *Batuliodes*, but here, instead of being evenly triangular with straight sides, it is produced toward tip, with the sides of the narrow produced part parallel and nearly straight and the apex rounded.

Vacronus n. gen.

While its general characters show conclusively that this genus belongs in the neighborhood of *Anepsius*, its very slender, filiform and altogether exceptional antennæ and the profound differences observable in the palpi and mentum and in its large eyes and scutellum, preclude any possibility of close or even tribal association with it, and I am therefore forced to conclude that *Vacronus* represents a distinct tribe, between the Anepsiini and the Nyctoporini. The type may be described as follows:

Form elongate, parallel, moderately convex, glabrous, moderately shining, pale and uniform reddish-brown in color throughout; head rather small, subquadrate, the sides at the middle subangulate and as prominent as the eyes, thence obliquely converging to the broadly truncate apex and, posteriorly, strongly converging for a short distance to the eyes, which are large, convex and near the base, the latter very feebly constricted; surface broadly impressed at each side anteriorly, rather finely, closely and asperulately punctate; antennæ half as long as the body, very slender and filiform, exactly equal in diameter from the base of the second joint to the apex, all the joints elongate, the second the shortest, the third but little longer than the fourth; prothorax two-fifths wider than long, three-fourths wider than the head and distinctly longer, parallel, widest at or just before the middle, the sides subevenly, rather strongly arcuate, straighter or feebly subsinuate toward the basal angles, which are slightly obtuse and distinct, the base broadly, very feebly arcuate, becoming transverse and straight toward the angles, a little wider than the apex, which is evenly sinuate, the angles rather obtuse but only slightly blunt; surface evenly convex, subexplanate near the sides, somewhat finely, very closely and confusedly punctate, not more coarsely but more deeply and coalescently so in fine irregular rugæ laterally; scutellum transverse, truncate; elytra truncate at base, almost twice as long as wide, between three and four times as long as the prothorax and evidently wider, gradually and acutely ogival behind, the sides parallel, evenly and feebly arcuate, broadly reflexed, the humeri rounded, slightly exposed at base, feebly and longitudinally prominent; surface finely, rather sparsely, confusedly punctured, more strongly externally, the punctures, especially toward the sides, each with a short carinule, not proceeding longitudinally but obliquely tangent to the puncture on its antero-outward side; abdomen minutely, very sparsely punctured, more coarsely and less sparsely toward the sides. Length 5.0 mm.; width 1.8 mm. California (Independence), — H. F. Wickham.....**tenuicornis** n. sp.

The single specimen in my cabinet is a female. The hind wings seem to be well developed, the relationship of the genus

to *Anepsius* being possibly somewhat similar to that of *Epitragus* to the Gnathosiini, as far as habits are concerned, *Anepsius* being wingless and epigeal.

Nyctoporis Esch.

This genus constitutes a type widely isolated in this part of the Tenebrionid series, by reason of the long dense hairs clothing the tarsi beneath, and, although much larger than *Anepsius* and presenting a very different appearance, owing to its dense and very coarsely sculptured integuments and costate elytra, a closer analysis seems to show that these conspicuous costæ are merely an extreme development of the regular series of short carinæ so prevalent in that genus. For *Nyctoporis* a distinct tribe is necessary, the Nyctoporini; it contains rather numerous species, confined, as far as known, to the true Pacific coast fauna of California and those in my cabinet may be separated by the following characters: —

Pronotum with two rounded discal impressions arranged transversely; head medially carinate; elytral ridges alternating very slightly in prominence 2

Pronotum without the discal impressions 5

2 — Elytral suture margined at each side by a regular series of small elongate tubercles 3

Elytral suture without the marginal series of tubercles 4

3 — Body rather stout, parallel, convex, brownish-black, slightly shining; head very coarsely, confluently foveate, less coarsely so anteriorly, the frontal margin nearly as in *Batuliodes*, the lateral lobes of the clypeus small but angularly prominent anteriorly; antennæ with the third joint a little shorter than the fourth; prothorax somewhat wider than long, much wider than the head, widest before the middle, the sides rounded, more converging basally than apically, the basal angles prominent, the apex sinuate, with the angles obtusely rounded; surface with very coarse deep and crowded or subconfluent foveæ, the lateral edges rather broadly and strongly reflexed; scutellum transverse, well developed, nearly as in *Vacronus*; elytra varying from a little more than one-half to about three-fourths longer than wide, evidently wider than the prothorax and two and one-half times as long, rather abruptly, very obtusely rounded behind, with the individual apical angles slightly prominent and divaricate, the sides parallel and feebly arcuate to the obtusely angulate and slightly prominent humeri, which are very narrowly exposed at base beyond the thoracic angles, the series of short and strongly elevated carinæ

5

feebly alternating in prominence, the intervals with single series of moderate punctures, each bearing anteriorly a small tubercle and a small suberect hair, which is similar to those of the head, pronotum and abdomen, the latter coarsely, closely and evenly punctate, the interspaces dull in lustre. Length 13.8–15.3 mm.; width 4.6–4.9 mm. California (San Francisco). [= *N. galeata* Lec.]..... ....**cristata** Esch.

Body smaller and notably more slender than in the preceding, blackish, the under surface and legs rufo-piceous, the small hairs pale and distinct; head nearly as in *cristata*, the third antennal joint slightly shorter than the fourth and longer than the fifth; prothorax nearly as in *cristata* throughout, except that the apex is almost rectilinearly truncate between the rounded and only very slightly produced angles and not broadly and angularly emarginate as in that species, and the sides are less converging toward base or less inflated before the middle; elytra more oval, gradually more narrowing basally, slightly wider than the prothorax, three-fourths longer than wide, the crests evidently alternating in prominence only near the base and toward apex, composed of smaller and shorter carinules than in *cristata*, the tubercles of the interspaces much more minute; abdomen coarsely but more sparsely punctured medially, the interspaces much more shining. Length 12.7 mm.; width 4.0 mm. California (Siskiyou Co.)..... .....**pullata** n. sp.

4 — Form narrower than in *cristata* and much smaller in size, brownish-black, the interspaces of the anterior parts and elevations of the elytra similarly shining, the surface with small sparse hairs; head similar but more strongly and obliquely narrowed anteriorly, the third antennal joint fully as long as the fourth and longer than the fifth; prothorax nearly similar in form and in its very coarse crowded sculpture, but with a distinct depression, extending obliquely and outwardly and obliquely backward from each of the rounded impressions; elytra oval, with parallel and somewhat strongly, evenly arcuate sides, fully three-fourths longer than wide and very much wider than the prothorax, the elongate tubercles forming the interrupted crests larger and less numerous than in *cristata*, with the alternating series only slightly more prominent, the punctures of the interspaces not, or only very faintly, tuberculiferous; abdomen less coarsely and more sparsely punctured medially. Length 11.4–13.2 mm.; width 3.8–4.4 mm. California (El Dorado and Sacramento Cos.).....**sponsa** n. sp.

5 — Alternate ridges of the elytra very much more prominently elevated throughout; head medially carinate as in *cristata*..... ..6

Alternate ridges not more prominent, all the series of small cariniform tubercles equal and only moderately elevated, the tubercles much smaller than in the *cristata* type; head without longitudinal carina..... 7

6 — Form elongate, convex, black, dull in lustre, the elevations shining, the sparse hairs short but distinct; head sculptured as in

cristata, subangularly prominent at the sides just before the eyes, the third and fourth antennal joints equal in length; prothorax but slightly wider than long, formed as in *cristata* and similar in its very coarse and crowded foveæ, without the two submedian impressions but with a distinct impression near each side at about the middle, the apex broadly sinuate, the apical angles somewhat advanced but rounded; elytra at least three-fourths longer than wide, gradually ogival at tip, with the individual angles acutely prominent and somewhat divaricate, the sides parallel and broadly arcuate, very distinctly wider than the prothorax, the humeri very obtuse, broadly but very obliquely exposed at base; elevated ridges irregularly crenulate along the summit, the intermediate series composed of somewhat close-set carinules, the intervals each with a single series of rather coarse, close-set and finely tuberculiferous punctures; abdomen coarsely, closely cribrate. Length 13.0–15.0 mm.; width 4.2–4.9 mm. California (Monterey)...**carinata** Lec.

Form much shorter and relatively stouter, black, the small hairs unusually short and inconspicuous; head as in *carinata*, subangularly prominent before the eyes and arcuately narrowed thence to the apex, the antennæ similar, piceous in color; prothorax distinctly wider than long, otherwise as in *carinata*, the apex similarly sinuate and the angles slightly advanced but rounded, the lateral impressions distinct; elytra barely one-half longer than wide, the more elevated ridges a little higher and almost evenly though very closely tuberculose, the carinules of the intermediate series more widely spaced, the finely tuberculiferous punctures of the intervals less close-set, the apex very obtusely rounded, with the individual angles scarcely at all prominent or divaricate, the sides parallel and arcuate, the humeri only slightly exposed at base; abdomen extremely coarsely but not quite so densely cribrate. Length 12.0–14.5 mm.; width 4.4–5.2 mm. California (locality unrecorded), — Cab. Levette..... .....**segnis** n. sp.

7 — Body moderately slender, convex, the elytra rather shining, black, the small hairs not conspicuous; head rather longer than wide, very coarsely and subconfluently foveate basally, less coarsely so before the middle from a well defined transverse line, the sides abruptly prominent before the eyes, obliquely and not very arcuately narrowed thence to the apex, with the sides notably reflexed; antennæ with the third and fourth joints equal; prothorax evidently wider than long, widest at apical third, where the sides are broadly arcuate, rather strongly converging thence to the base, becoming feebly sinuate, the basal angles acute and more or less prominent, the apex transverse, feebly sinuate at the middle and near each of the angles, which are rounded and not more produced than the median lobes; surface very coarsely and confluently foveate, evenly and moderately convex, feebly impressed near each side at about the middle, the sides rather broadly, strongly reflexed; scutellum large, transverse, very coarsely sculptured; elytra three-fourths to four-fifths longer than wide, distinctly wider than the

prothorax, with the somewhat prominent and angulate humeri widely and only a little obliquely exposed at base, the sides parallel and broadly arcuate, the apex rather gradually ogival, with the individual angles acute, prominent and everted; surface with only slightly elevated, even series of short and close-set carinæ, the alternate series more prominent toward base, the intervals with single series of somewhat coarse and perforate, moderately close-set tuberculiferous punctures, the suture narrowly margined with unevenly rugose carinules; abdomen only moderately coarsely and not very closely punctured medially, except at base. Length 14.0–15.0 mm.; width 4.8–4.9 mm. California (Oakland).

æquicollis Esch.

Body nearly as in *æquicollis* but somewhat smaller and less stout, black, similar in lustre and in the short sparse hairs; head before the eyes less abruptly, more feebly prominent and thence less strongly converging and more arcuate to the apex, almost similarly sculptured; antennæ with the third joint very distinctly longer than the fourth; prothorax nearly similar in form and sculpture though much less dilated anteriorly, the sides less converging toward base and less reflexed, almost as long as wide; elytra nearly as in *æquicollis* in form and sculpture, except that the humeri are but little exposed at base, and the surface at each side of the suture is more finely, confusedly tuberculose and less differentiated from the first series of punctures, the alternate series of carinules scarcely perceptibly more prominent toward base; abdomen, for the present genus, rather finely and notably sparsely punctate toward the middle and not densely so even on the first segment. Length 13.7 mm.; width 4.4–4.5 mm. California (Truckee) ....**maura** n. sp.

Body smaller than in the two preceding and more slender, brownish-black or paler, slightly shining; head nearly as in *æquicollis*, the oblique sides anteriorly strongly converging and nearly straight, the basally very coarse sculpture becoming very gradually and only slightly less coarse anteriorly, and not abruptly so and materially finer anteriorly as in that species; antennæ and legs thinner, the third joint of the former distinctly longer than the fourth; prothorax nearly as long as wide, less dilated anteriorly, the sides sometimes very feebly converging toward base, otherwise nearly as in *æquicollis*; elytra but little less than twice as long as wide, distinctly wider than the prothorax, with evenly arcuate sides but with the humeri only slightly exposed at base and but slightly prominent, the apex somewhat gradually, acutely ogival, the individual angles more minutely prominent and divaricate; surface with the sculpture similar but finer, the alternate series of carinules scarcely perceptibly more prominent near the base; abdomen coarsely but only moderately closely punctate medially. Length 12.4–13.0 mm.; width 3.75–4.1 mm. California (locality unrecorded),—Cab. Levette.....**tetrica** n. sp.

The species described above under the name *sponsa*, is sometimes identified as *cristata* Esch., but erroneously, as it is confined to the eastern side of the Sacramento Valley and to the Sierras, while the locality of *cristata* is the sea-coast region in the neighborhood of San Francisco; the name *galeata* Lec., will therefore have to fall as a synonym of that species. One specimen of *segnis* has the cariniform tubercles of the series between the ridges very remotely separated, giving it a remarkably different facies, but it is probably an aberrational form. I have been unable to discover any clearly marked secondary sexual characters in this genus.

The genera *Cryptoglossa* Sol., *Centrioptera* Mann., with its subgenus *Oochila* Lec., and *Schizillus* Horn, the last having the antennæ as in *Centrioptera* but with the eyes completely divided, from a tribe apart, known as the Cryptoglossini. It appears to be much more closely related to the Nyctoporini and *Anepsius* than to the Asidini, in many important characters. The species are large and well known in collections, so that a special revision is not necessary at the present time: no further allusion will be made to it, therefore, except to describe the following species of the genus *Centrioptera*: —

Body nearly as in *muricata* Lec., but rather smaller and decidedly more slender, deep black in color and strongly shining, glabrous; head rather wide than long, the sides anteriorly less converging and the apex much more broadly truncate than in *muricata*, with very broadly rounded angles, the surface broadly impressed transversely just behind the middle, the impression not attaining the sides, somewhat coarsely but sparsely punctured anteriorly, except in a large median impunctate area, finely, sparsely punctate basally; prothorax formed almost exactly as in *muricata* throughout and similarly punctured but less transverse, more shining and with the surface near the sides not somewhat broadly and very evidently reflexed, as in that species, but continuing the moderate convexity evenly to the prominent marginal bead; scutellum larger and more transverse; elytra in general similar to those of *muricata* in form and sculpture but much less inflated, strongly shining; under surface and legs nearly similar, except that they are strongly shining and not opaque, the tibiæ and tarsi much less setulose and the tarsal claws notably smaller and less arcuate. Length 16.5 mm.; width 6.3 mm. Utah (southwestern), — C. J. Weidt.....**utensis** n. sp.

I have before me but a single specimen of undetermined sex, though, because of the scarcely flattened median parts of the abdomen, it is probably a female.

ADDENDA.

I.

While the preceding revision was under way and in fact largely completed, I received considerable sets of specimens from Warren Knaus, H. F. Wickham and F. H. Snow, impelling me to rewrite more than half the tabular statement of *Metoponium* and virtually all of *Bothrotes*, but advantage was taken of this opportunity to eliminate a number of more or less doubtful forms and to suggest more practicable dichotomous characters, so that I am much better satisfied with the result. I have to thank my colleagues for thus adding materially to the present knowledge of the various groups.

In response to my request, Mr. Champion very kindly sent me all the Central American and Mexican species which were at his disposal, and, with great generosity, placed a number of them permanently in my collection. The importance of this in permitting a direct comparison between the tropical and Sonoran species can well be understood; it adds a great deal to the usefulness of this revision. It is especially gratifying to observe that the genera proposed above for our fauna, hold perfectly good for the Mexican species, although naturally a few additional genera are required for some of them. In definitely rejecting the generic name *Emmenastus*, it became necessary to know the tropical North American species, in order to assign them properly, as all but one were described under that title in the "Biologia." By help of the representative forms sent me, serving as a key, the following generic dispositions are suggested for the numerous species described by Mr. Champion: —

Eurymetopon brevicolle is assignable to the genus *Telabis*.

Emmenastus chiriquensis, *belti*, *alatus*, *salvini*, *intermedius*, *longicornis*, *variabilis*, *canaliculatus*, *brevipennis*, *solitarius*, and *rotundicollis*, may be placed in the genus *Armalia*, which seems to be peculiar to the hot and generally low country bordering the Gulf of Mexico and the Caribbean Sea, a region climatically wholly distinct from the dry elevated Sonoran regions supporting the majority of the genera. Of the species mentioned, *variabilis*, *chiriquensis* and *belti* are before

me in actuality; they are perfectly congeneric with *texanus* and *angularis* and are, in fact, so similar to our types in general form, sculpture and coloration, as to be discriminated only under more or less careful observation. The position of the other species is simply inferred from the original descriptions and are therefore to some extent provisional.

Emmenastus parallelus, *tenebrosus*, *guatemalensis*, *subapterus*, *seriatus*, *mexicanus*, *vicinus* and *ambignus*, are to be referred to typical *Hylocrinus*, the last with considerable doubt however. The first three are represented in the material sent by Mr. Champion and are exactly congeneric with *longulus* Lec.

Emmenastus maneus, *curtus*, *glabratus*, *lentus*, *rugicollis*, *pulvinatus*, *picipes*, and *ellipticus* are members of the genus *Steriphanus*, and the first four are before me at present. *Lentus* has the antennæ unusually long and slender and *glabratus* has the eyes unusually deeply emarginate and the antennæ a little shorter.

Emmenastus stolidus is altogether exceptional in the Eurymetoponini, in having the eyes completely divided, more through the greatly extended posterior canthus than any unusual development of the anterior, the latter intruding upon the eye but little more than in normal species of *Steriphanus*. This character, in connection with the rounded basal angles of the prothorax and sparse vestiture of long stiff hairs on the under surface of the tarsi, renders it necessary to propose a new genus for *stolidus*, which may take the name **Steriphanides** (n. gen.). The form of the body is more evenly elliptical than in *Steriphanus*, approaching that seen in *Cryptadius* and *Stictodera*, but the sculpture is exceptionally feeble. The basal joint of the hind tarsi is evidently longer than the fourth.

Emmenastus foveicollis, *lævicollis* and *confusus* are represented among the material and belong to *Ditaphronotus*, as stated before under that genus. The type described on p. 341, under the name *championi*, is allied to *foveicollis*, but differs in its more abbreviated form, more rounded sides of the prothorax and elytra, more coarsely punctured and more impressed elytral series, subopaque and not strongly shining integuments and other characters. The convexity of the body is not especially

pronounced in either case, but *confusus* is much more depressed and differs greatly in the form of the very deep basal excavations of the pronotum; is is probably not more than subgenerically different however.

Emmenastus igualensis is a perfectly typical member of the genus *Emmenides*. It is almost as large as *punctatus* Lec., but rather more abbreviated, duller in lustre, with much finer punctures throughout and with decidedly less prominent eyes, the resemblance in general habitus, as well as in the essential characters of the genus, is complete.

Emmenastus constrictus, from the Pacific coast State of Guerrero, must form a special genus, apparently allied to *Armalia*, but differing in the form of the front, which is bisinuate, with the very short median lobe subangularly rounded and feebly serrulate and having the left mandible more distinctly toothed above, the right very strongly. The eyes are large and convex, prominent, coarsely faceted and only feebly emarginate anteriorly, the antennæ slender and moderate in length. It has somewhat the facies of a very small *Armalia* and may take the generic name **Micrarmalia** (n. gen.). The form of the front and mandibles would seem to betray some relationship, also, with the Trimytini, through *Pescennius*, and indeed it may prove difficult to maintain the identity of the two tribes Eurymetoponini and Trimytini, when all the genera become known.

Some of the other genera proposed by Mr. Champion may be remarked upon as follows: —

Mesabates Champ.

This genus is represented by *latifrons*, a singularly short, stout and oblong-oval species, with a large head, which is transverse and feebly bisinuate anteriorly, with the median lobe short and transversely truncate, the eyes moderate, coarsely faceted and more than half divided, with short supra-orbital carina, and the antennæ unusually developed, being long, very heavy and scarcely at all enlarged distally. The metasternum is extremely short, about half as long as the first ventral but with the transverse ante-coxal grooves evident. It belongs near *Melanastus* in the Eurymetoponini.

Of the two species subsequently attached to *Mesabates*, *spissicornis* may possibly be congeneric though probably not, but *inæqualis* is certainly generically different. In *inæqualis* the head is moderate in size, remotely and feebly bisinuate at apex, with the very short and broad median lobe rectilinearly truncate, the eyes rather small, not prominent but only slightly emarginate anteriorly, with a longer straight and oblique orbital carina, and the antennæ are long, very slender and enlarged distally. The prothorax is much narrower than the elytra, subtruncate at base and the elytra oblong, short and punctato-seriate except apically. The metasternum is very nearly as long as the first ventral, with the ante-coxal grooves obsolete and represented by a row of smaller punctures and the met-episterna are rather broad. It constitutes the type of a genus very near *Steriphanus*, which may be named **Mesabatodes** (n. gen.).

Posides Champ.

In its general characters this genus is also very close to *Steriphanus*, the antennæ, eyes, palpi and proportion of the various parts being similar, but the mandibles are more strongly toothed above, the left distinctly so and the right still more strongly, and the apices are not bifid but truncate. The front of the head is transverse and very feebly angulate, the lateral lobes projecting anteriorly somewhat further, with their sides oblique, becoming parallel toward the eyes. The prothorax is subequal in width to the elytra, as in *Steriphanus*, and is strongly lobed at base, and the metasternum is slightly shorter than the first ventral, with obsolete ante-coxal grooves and moderately narrow side-pieces. The genus differs from *Steriphanus*, besides, in having the tarsi densely clothed beneath with short fulvo-cinereous pubescence.

Pescennius Champ.

This genus is a member of the Trimytini, differing very much from the other genera in its short and angular epistomal lobe, though partially connected in this respect through the subgenus *Pimalius*, of *Trimytis*, where the lobe becomes rounded and less prominent than in *Trimytis* or *Chilometopon*. The hairy vestiture of *Pescennius* is no more exceptionally significant in

the Trimytini, than that of *Trichiotes* or *Oxygonodera* in the Triorophini.

Of the other genera described by Mr. Champion, I can state nothing positively at present, but it is possible that *Sœmias* may be a member of the Trimytini and *Mencheres* of the Eurymetoponini.

II.

The South American genera of the Epitragini have not been investigated systematically thus far, though a number of species have been described by Berg, Fairmaire and others. As represented by material in my cabinet they may be known as follows: —

Mandibles bifid at tip; elytra with punctured series throughout the width, acute at tip.....2

Mandibles truncate at tip.....3

2 — Epistoma broadly sinuate; head without supra-orbital ridge, the eyes flat and rather finely faceted; prothorax sinuate at apex, with the angles acute and somewhat anteriorly prominent; tarsi with short dense pubescence beneath. Atlantic South America, extending into Central America. [Types *fuscus* Lat., *aurulentus* Kirsch and *rigens* Csy.].....**Epitragus** Latr.

Epistoma produced and rounded, with its apex narrowly and feebly sinuate or sinuato-truncate; eyes convex and prominent, coarsely faceted, with fine supra-orbital ridges which are bordered internally by a depressed area somewhat as in *Metopoloba*, the body similarly polished and subglabrous; prothorax truncate anteriorly, with obtuse and narrowly rounded or blunt and wholly non-prominent apical angles; tarsi with tufts of long dense pubescence beneath. Pacific South America. [Type *P. solieri* n. sp.].
Parepitragus n. gen.

3 — Prosternum produced, acute and received within a deep excavation of the mesosternum; last antennal joint moderate, never longer than the tenth; front bisinuate, the middle lobe slightly advanced and rounded; eyes flat, coarsely faceted, with very fine supra-orbital carinæ which are not bordered internally by a depressed area; prothorax emarginate anteriorly, with acute and prominent angles; elytra very acute, with even punctured series throughout the width; tarsi densely pubescent beneath. Atlantic South America, extending into Central America. [Type *Epitragus godmani* Champ.].....**Epitragopsis** Csy.

Prosternum finely acute posteriorly but only slightly produced, not entering the large and deep mesosternal excavation, which remains unaltered; last antennal joint elongate, as long as the two preced-

ing combined; front not bisinuate, with a large and evenly parabolic epistomal lobe; eyes convex, prominent and coarsely faceted, with short and very fine supra-orbital carinæ which are not bordered by a depressed area; prothorax short, broadly and deeply sinuate at tip, with the angles right and more or less blunt; elytra with coarse and confused punctuation throughout; tarsi with pads of short dense pubescence beneath. Atlantic South America. [Type *E. brevicollis* n. sp.]..... .....**Eunotiodes** n. gen.

Prosternum deflexed and vertical behind the coxæ, not in the least produced, the mesosternum with a small and feeble indentation remaining as a vestigial character; epistoma between the oblique sutures very broad, trapezoidal, the apex broadly and rectilinearly truncate; last antennal joint smaller than the tenth, oval; eyes only feebly convex, rather coarsely faceted, the carinæ and vertex as in *Eunotiodes;* prothorax not abbreviated, sinuate at apex, with acute and more or less prominent angles; elytra with coarse and confused punctuation throughout, rapidly narrowed and acute at tip; tarsi slightly grooved beneath except toward base, with short, stiff sparse spinules, not at all pubescent beneath. Atlantic South America. [Type *O. farctus* n. sp.].....**Omopheres** n. gen.

Epitragopsis, which in the body of the present paper is treated as a subgenus of *Lobometopon*, is here regarded as a distinct genus, a course that would be necessary in any event in order to compare it with other South American generic types. The genus *Epitragus* has been alluded to in the present paper under the head of *rigens* (p. 381), and by Mr. Champion in the "Biologia."

The genus *Parepitragus* is represented by the following species: —

Moderately stout and convex, polished, dark castaneous, the pubescence very short and sparse, fulvous and inconspicuous, more noticeable near the eyes; head moderate, not very coarsely, sparsely punctate, more closely near the eyes and on the transversely tumid epistoma; prothorax nearly one-half wider than long, moderately narrowed at apex, the sides gradually converging and arcuate anteriorly, becoming parallel and feebly arcuate toward base, the basal angles right, not blunt but not at all prominent, the apical obtuse and blunt; surface broadly, moderately convex, impressed at the base near each side, more or less finely, very sparsely punctured, with an obsolescent impunctate area medially, more coarsely and closely punctate only very near the sides and in the basal impressions; scutellum semi-circular; elytra three and one-half times as long as the prothorax and nearly a third wider, gradually ogival and acute behind, the sides feebly arcuate, strongly rounded at base to the thoracic angles,

the humeri exposed basally, the callus rather strong; surface impressed near the suture apically, the convex intervals there becoming stronger, having throughout even, slightly impressed series of moderately coarse and widely spaced punctures, which are but little coarser laterally but becoming asperate toward tip; the intervals feebly rugulose, slightly convex, minutely, sparsely and confusedly punctulate; abdomen finely but strongly, sparsely punctate and somewhat pubescent. Length 10.7–12.3 mm.; width 4.3–5.0 mm. Ecuador (Guayaquil), — Rolle.

solieri n. sp.

The four examples sent me vary a good deal in size, the smaller probably being males but without any distinct sexual characters.

The genus *Eunotiodes* has for its type a species which may be described as follows: —

Body stout, oval, convex, somewhat alutaceous, blackish-castaneous, virtually glabrous; head very coarsely, not closely punctured medially, less coarsely and more closely laterally and anteriorly, the last antennal joint elongate, pyriform, with the apex compressed and truncate; prothorax twice as wide as long, the apex scarcely narrower than the base, the sides very evenly and rather strongly arcuate throughout, the basal angles obtuse and blunt; surface evenly and moderately convex, the pronounced apical bead ending abruptly inwardly at lateral fourth, the punctures moderately coarse and sparse, deep and without median smooth line medially, becoming coarse and closer but not dense laterally; scutellum ogival, wider than long; elytra two-thirds longer than wide, nearly one-half wider than the prothorax and more than four times as long, rapidly narrowed and acutely ogival in about posterior third, the sides parallel, feebly arcuate to the rectangular but rounded humeri, which are widely exposed at base, the surface even, with the punctures perforate, coarse and sparse, still coarser but only a little closer laterally; abdomen finely but strongly, sparsely punctured medially. Length 11.7 mm.; width 5.3 mm. Argentina (Mendoza), — Rolle.....**brevicollis** n. sp.

The sex of the single specimen before me is not evident. The large rounded epistomal lobe is finely pectinate about its contour.

The type of *Omopheres* may be thus described: —

Form very stout, convex, oval, polished, subglabrous, castaneous in color; head moderately coarsely but not very closely punctate, more closely on the flattened trapezoidal epistoma; prothorax relatively small, nearly one-half wider than long, the sides evenly and moderately converging and evidently arcuate from base to apex, subparallel in about basal third, the basal angles obtuse and somewhat blunt, the apical acute and not at all blunt; surface

evenly convex, the apical bead extending entirely across, rather coarsely, sparsely and irregularly punctate, without smooth line, but little more coarsely or less sparsely so laterally, except in a narrow longitudinal area near lateral sixth and along the lateral edges, where the punctures are less coarse but dense; scutellum moderate, fully as long as wide, narrowly rounded; elytra two-thirds longer than wide, almost four times as long as the prothorax and nearly two-thirds wider, rapidly and angularly narrowed in about apical fourth, the apex acute, the sides parallel and feebly arcuate to the broadly rounded and rectangular humeri, which are widely exposed at base, the elongate callus very strong; surface not impressed apically, even, without impressed lines, coarsely and sparsely, confusedly punctate, the punctures becoming very coarse and muricate, though not much more close-set, laterally; abdomen sparsely, moderately finely punctate. Length 14.8 mm.; width 6.3 mm. Argentina (Mendoza), — Rolle.

farctus n. sp.

It is possible that this may be identical with some one of the forms described by Berg or Fairmaire, but I am unable to confirm this at present, as the species are numerous and rather closely allied; I have two others among my material, both undetermined. All of these species, in fact, may possibly have been previously described but, as the literature is inaccessible at present and it became necessary to definitely fix the types of the new genera here defined, they are described as new with sufficient detail to secure identification.

III.

In the new edition of the European Catalogue of Heyden, Reitter and Weise, some changes of nomenclature appear, that were overlooked in drawing up the table of tribes on pages 277–282 of this paper. It appears that the genus *Capnisa*, of Lacordaire, must be designated *Gnathosia* Fischer, in future, and the genus *Gnathosia*, of Lacordaire, be known under the name *Dailognatha* Esch. It is not possible for me to confirm this nomenclature at present, but it should be recalled as significant that Motschulsky, in characterizing his *Emmenastus compactus* (ante p. 287), makes use of language that is absurd if we accept *Capnisa* in the Lacordairean sense, but perfectly intelligible if we consider *Capnisa*, of Lacordaire, to be in reality the *Gnathosia*, of Fischer, the outline in this genus being oval and

somewhat like that of *Zophosis*. I am inclined, therefore, to believe that the change of names given in the catalogue referred to is necessary, and the tribal name "Capnisini," on page 279 of this work, should therefore read Gnathosiini and the name "Gnathosiini," on the same page and wherever else used in this paper, should give place to Tentyriini.

In this connection it may be called to mind that the definition of the Tentyriini (Gnathosiini) given on page 279, states that series of punctures are wanting on the elytra. This character certainly pertains to the vast majority of the tribe in question, but in a few genera, such as *Mesostena*, there are rows of coarse and well defined punctures resembling those of *Triorophus*. The peculiar antennal structure and form of the scutellum are, however, precisely as in all the other genera of the tribe Tentyriini as here defined, the antennæ being wholly different from anything known in the American tribes.

IV.

Just as the final page proofs of this paper reach me, I receive, through the kindness of Dr. W. F. Rainbow, of the Australian Museum, Sydney, specimens of the Australian genus *Zopherosis*, and here make some hurried comparative studies. Although it undoubtedly combines the characters of the Zopherini and Nosodermini, having the structure of the ligula and antennæ very much as in the former and the mandibles and general facies as in the latter, I am inclined to regard it as constituting a special tribe, Zopherosini, having the ligula very short and broad but with the palpi, not minute and hidden as in Zopherini, but large and distinct, the mandibles bifid at tip and the antennæ nearly as in *Zopherus* and received in similar propleural fossæ, but with the last three transverse joints, forming the club, not solidly united as in Zopherini but free and very much as in Usechini. The depressed tuberculose upper surface of the body is of the same order as in Nosodermini, but the very small ligula of the latter tribe is sufficiently distinctive. *Zopherosis* combines in a remarkable manner the characters of the Zopherini, Nosodermini and Usechini, confirming the existence of old land connections between Australia and South America.

PROCEEDINGS

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. IX, PP. 523–558. MARCH 7, 1908.

ORGANIZATION AND MEMBERSHIP OF THE WASHINGTON ACADEMY OF SCIENCES, 1907.

CONTENTS.

PAGE

Introduction 524
Act of Incorporation 525
By-Laws 527
Rules respecting Publication 530
Tenth Annual Report of the Secretary, 1907 531
" " " " " Treasurer, " 534
Officers and Committees 1908 537
List of Members ..... " 539
Index 549

INTRODUCTION.

In this brochure has been collected material relating to the organization and present membership of the Academy. It includes the Act of Incorporation, the By-Laws, and Rules respecting Publication as now in force, with lists of officers and committees for 1908.

The list of members gives simply the name and address of each member, and has been corrected to February 1, 1908.

ACT OF INCORPORATION

We, the undersigned, persons of full age and citizens of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 545 to 552, inclusive, of the Revised Statutes of the United States relating to the District of Columbia, as amended by an Act of Congress entitled "An Act to amend the Revised Statutes of the United States relating to the District of Columbia and for other purposes," approved April 23, 1884, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the society is the WASHINGTON ACADEMY OF SCIENCES.

2. That the term for which it is organized is nine hundred and ninety-nine years.

3. That its particular business and objects are the promotion of science, with power:

a. To acquire, hold, and convey real estate and other property and to establish general and special funds.

b. To hold meetings.

c. To publish and distribute documents.

d. To conduct lectures.

e. To conduct, endow, or assist investigation in any department of science.

f. To acquire and maintain a library.

g. And, in general, to transact any business pertinent to an academy of sciences.

4. That the affairs, funds, and property of the corporation shall be in general charge of a Board of Managers, the number of whose members for the first year shall be nineteen, all of whom shall be chosen from among the members of the Academy.

Witness our hands and seals this 18th day of February, 1898:

(Signed)

J. R. EASTMAN	J. W. POWELL
F. W. CLARKE	GEO. M. STERNBERG
G. K. GILBERT	H. N. STOKES
ARNOLD HAGUE	CHARLES D. WALCOTT
L. O. HOWARD	LESTER F. WARD
W J McGEE	FRANK BAKER
C. HART MERRIAM	BERNARD R. GREEN

DISTRICT OF COLUMBIA, *to wit:*

I, John D. McChesney, a Notary Public in and for the District aforesaid, do hereby certify that J. R. Eastman, F. W. Clarke, G. K. Gilbert, Arnold Hague, L. O. Howard, C. Hart Merriam, J. W. Powell, Geo. M. Sternberg, H. N. Stokes, Chas. D. Walcott, Lester F. Ward, W J McGee, Frank Baker and Bernard R. Green, parties to a certain Certificate of Incorporation, bearing date on the 18th day of February, 1898, and hereto annexed, personally appeared before me in the District aforesaid, the said J. R. Eastman, F. W. Clarke, G. K. Gilbert, Arnold Hague, L. O. Howard, C. Hart Merriam, J. W. Powell, Geo. M. Sternberg, H. N. Stokes, Chas. D. Walcott, Lester F. Ward, W J McGee, Frank Baker and Bernard R. Green, being personally known to me as the persons who severally made and signed the said certificate and acknowledged the same to be their certificate, act and deed.

Given under my hand and notarial seal, this 18th day of February, 1898.

JNO. D. MCCHESNEY,
Notary Public.

[SEAL.]

Endorsed as follows:

9:20 A. M. Received for record February 21, 1898. Recorded in liber 8, fol. 207 *et seq.*, Acts of Incorporation for Dist. of Col.

H. P. CHEATHAM,
Recorder.

BY-LAWS.

(In force February 1, 1908.)

ARTICLE I. — *Members.*

SEC. 1. The Washington Academy of Sciences shall comprise 5 classes of members, as follows: *Resident members*, *non-resident members*, *life members*, *honorary members* and *patrons*.

SEC. 2. *Resident*, *non-resident*, *life* and *honorary members* shall be persons who by reason of original research or scientific attainment are deemed eligible to these classes. Resident members shall be chosen from the Affiliated Scientific Societies of Washington. Non-resident members shall be chosen from localities outside the District of Columbia, and honorary members may be residents of any country. Any resident or non-resident member in good standing may become eligible to life membership by the payment of $100. Patrons shall be persons who have given to the Academy not less than $1,000, or its equivalent in property. On removing to the District of Columbia and acquiring membership in one of the Affiliated Societies non-resident members shall thereby become resident members. Resident members, non-resident members, life members and patrons who have been members, and they only, shall be entitled to vote. The annual dues of resident and non-resident members shall be five dollars; life members, honorary members and patrons shall pay no dues. Members whose dues are in arrears for more than one year shall be dropped from the roll of the Academy, unless the Board of Managers shall otherwise determine.

SEC. 3. Nominations for membership shall be endorsed by at least 3 Members of the Academy, who shall present in writing a statement of the qualifications of the nominee, with a list of his more important publications; and such nominations shall be referred to the board of Managers for consideration.

ARTICLE II. — *Officers.*

SEC. 1. The officers of the Academy shall be chosen from the resident members, and shall be a President, one Vice-President from each of the affiliated societies, a Corresponding Secretary, a Recording Secretary and a Treasurer, whose terms of office shall be one year, and 9 Managers, grouped in 3 classes of 3 each, whose terms of office shall be 3 years. Collectively they shall constitute the Board of Managers.

SEC. 2. The President and the Treasurer are authorized to assign securities belonging to the Academy and indorse financial and legal papers necessary for the uses of the Academy.

SEC. 3. The Board of Managers shall transact all business of the Academy not otherwise provided for, and shall have power to fill vacancies in its own membership until the next annual election. Vacancies in the office of Vice-President shall be filled on nomination by the appropriate affiliated societies.

ARTICLE III. — *Meetings.*

SEC. 1. The Annual Meeting shall be held on the third Thursday of January each year. At this meeting the reports of the Secretaries, Treasurer, and Auditing Committee shall be presented and officers for the ensuing year shall be elected.

SEC. 2. Other meetings shall be held at such time and place as the Board of Managers may determine.

SEC. 3. Twenty resident members of the Academy shall constitute a quorum for the transaction of business.

ARTICLE IV. — *Committees.*

SEC. 1. The Board of Managers may appoint such standing and special committees as it deems necessary.

SEC. 2. The President shall appoint in advance of the annual meeting an Auditing Committee consisting of 3 persons, none of whom are officers, to audit the accounts of the Treasurer.

ARTICLE V. — *Elections.*

SEC. 1. At each annual meeting there shall be elected by ballot a President, a Corresponding Secretary, a Recording Secretary, a Treasurer, and 3 Managers, who shall serve until the close of the meeting at which their successors are chosen. A majority of the votes cast shall be necessary to elect. Members whose dues are in arrears for one year shall not be entitled to vote or be eligible for any office in the Academy.

SEC. 2. Resident members shall be elected by the members of the Academy, and three fourths of the votes cast shall be necessary to elect. An election shall be void if the person elected does not within 3 months thereafter pay his annual dues or satisfactorily explain to the Board of Managers his failure to do so.

SEC. 3. Non-resident members, life members, honorary members, and patrons shall be elected by the Board of Managers, and three fourths of the votes cast shall be necessary to elect. The Board shall have power to determine and change the status of resident members to non-resident.

ARTICLE VI. — *Coöperation.*

SEC. 1. The Academy may act as a federal head of the Affiliated Scientific Societies of Washington, with power to conduct joint meetings, publish a joint directory and joint notices of meetings, and take action in any matter of common interest to the affiliated societies: *Provided*, It shall not have power to incur for or in the name of one or more of these societies any expense or liability not previously authorized by said society or societies.

SEC. 2. The term 'affiliated societies' shall be held to cover the Anthropological, Biological, Chemical, Entomological, National Geographic, Geological, Medical, and Philosophical Societies and

such others as may be hereafter added by a majority vote of the members of the Academy, the vote being taken by correspondence.[1]

SEC. 3. One Vice-President may be nominated by each affiliated society from the members of the Academy, subject to election by a majority vote at a meeting of the Academy.

SEC. 4. Any affiliated society may nominate candidates for membership in the Academy.

ARTICLE VII. — *Amendments.*

These By-Laws may be amended in the following manner:

Written notice of proposed change signed by at least three resident members, may be presented at any meeting of the Academy. Such notice shall be referred to the Board of Managers for consideration and recommendation. The Board of Managers shall consider the proposed change and return it to the Academy for action, with such amendment or recommendation as it deems wise. A two-thirds vote of the members voting shall be necessary to adoption.

[1] The following have been added to the list of 'affiliated societies' under the authority of this section:

The Botanical Society of Washington.
The Columbia Historical Society.
The Washington Society of the Archeological Institute of America.
The Society of American Foresters.
The Washington Society of Engineers.

RULES RESPECTING PUBLICATIONS.

1. The Proceedings of the Washington Academy of Sciences shall be issued in dated brochures, paged consecutively for the volume.

2. A brochure may comprise one or more papers, according to length, at the option of the Committee on Publication.

3. The date on each brochure shall be that of actual publication, which shall be one day later than the date of delivery by the printer to the Committee.

4. Each brochure shall be distributed on the date of its publication. Copies shall be sent to all members of the Academy, to subscribers and to a library and exchange list approved by the Board of Managers.

5. At the close of each volume, which shall coincide as nearly as possible with the calendar year, a brochure comprising the title page, contents and index of the volume shall be issued.

6. The regular edition shall consist of twelve hundred copies.

7. Contributors to the Proceedings must be members of the Academy, or of one of the Affiliated Societies; provided, however, that in exceptional cases the Board, by a three-fourths vote of the members voting at a stated meeting, may accept for publication papers contributed by non-members of the Affiliated organizations.

8. Papers offered for publication shall be delivered to the Chairman of the Committee on Publication, who shall be Editor of the Proceedings. The Editor shall submit to the Committee an estimate of cost, and shall see that papers are promptly examined in such manner as the Board of Managers may direct.

9. Manuscript submitted for publication must be in form, as well as in substance, ready for the printer. It must be complete as to text and illustrations, must be perfectly legible (preferably typewritten), and must be preceded by a brief table of contents.

10. The Academy shall not be responsible for the cost of revising manuscripts or illustrations. The cost of proof corrections due to alterations made by the author shall be charged to him.

11. Papers accepted for publication in the Academy's Proceedings must not be previously published elsewhere except by consent of the Board of Managers of the Academy.

12. Authors' separates shall not differ in any particular from the regular edition. Any desired number may be ordered in advance through the Committee on Publication, at the expense of the author, and at a rate of cost agreed upon by the Committee and the printer.

13. Authors shall receive, free of cost, thirty copies of their papers.

TENTH ANNUAL REPORT OF THE SECRETARY, 1907.

To the Washington Academy of Sciences:

During the period from January 17, 1907, to January 16, 1908, the Academy has held the following meetings:

January 17, 1907 — Annual meeting for the election of officers, etc.

January 31, 1907 — Meeting to hear a paper on "The Dominant Tectonic Lines of California," by Professor Andrew C. Lawson. Discussed by Dr. George F. Becker, Dr. Waldemar Lindgren and Dr. Ralph Arnold.

February 26, 1907 — Meeting to hear a paper on "Heredity and Mendel's Law," by Dr. Charles Benedict Davenport. Discussed by O. F. Cook and W. J. Spillman.

April 2, 1907 — Meeting to hear a paper on "Modern Views of the Ultimate Structure of Matter," by Dr. Joseph Larmor. Discussed by Professor F. W. Clarke and Professor A. G. Webster.

May 23, 1907 — Meeting to commemorate the two hundredth anniversary of the birth of Linnæus. An address on the life and work of the great naturalist was made by Professor Edward L. Greene; also one on the relation of Linnæus to zoölogy by Dr. William H. Dall.

November 25, 1907 — Meeting to hear an address by Dr. David Starr Jordan upon "The Human Harvest."

January 7, 1908 — Meeting to hear an address on "Problems of the Desert," by Dr. D. T. MacDougal.

The Board of Managers has held nine meetings for the transaction of business.

On January 8, 1907, the Board considered an application made by the Washington Society of Engineers for affiliation with the other scientific societies and the Washington Academy of Sciences. The Board considered this application favorably and directed that a vote be taken by correspondence in accordance with Article VI, Sec. 2, of the By-Laws. This vote was finally canvassed on April 10, 1907, resulting as follows:

Number of members of the Academy	346
Necessary to a choice	174
For the admission of the Washington Society of Engineers	234
Against the same	3
Declined to vote	2

The Society of Engineers was therefore admitted to the group of affiliated societies.

One of the pleasant features in scientific circles during the season was the visit to this city of the International Zoölogical Congress which occurred from September 3, to September 6, 1907. It will be remembered that on December 11, 1906, the Board of Managers of the Academy appointed a local committee of considerable size, of which Mr. L. O. Howard was chairman, to arrange for the reception of the Congress in Washington. By the exertions of this committee a sufficient sum of money was raised for the entertainment of the Congress, the Academy contributing thereto $100, of which, however, $59.61 was returned unused. A suitable program of entertainment was arranged, including a smoker at the Cosmos Club, a luncheon at the National Zoölogical Park, a visit to the Library of Congress, a visit to Mount Vernon, a reception at the National Museum and visits to the scientific laboratories of the Government. Delegates were sent by the Academy to the general meeting of the Congress at Boston.

The Academy has suffered the following losses by death during the year and not hitherto reported:

Resident Member:

James J. Carroll.. .....died September 16, 1907.

Non-resident Members:

George W. Atherton..... ...died July 24, 1906.
W. O. Atwater.....died September 22, 1907.
Nicholas Senn..... .....died January 2, 1908.
S. E. Solly.....died November, 1906.
R. S. Sutton.....died April 21, 1906.

The statistics of membership at this date are as follows:

Patrons:

At date of last report	8		
Elected during the year..... ...	0	8	8

Honorary Members:			
At date of last report	1		
Elected during the year	0	1	1
Life Members:			
At date of last report	1		
Elected during the year	0	1	1
Resident Members:			
At date of last report	171		
Elected and qualified during this year	5		
Elected previously, but qualified during this year	2	178	
Deceased	1		
Resigned	4		
Dropped for non-payment of dues	1	6	172
Non-resident Members:			
At date of last report	175		
Elected previously, but qualified during this year	7	182	
Resigned	10		
Deceased	5	15	167
			349
Counted twice			1
Total membership January 16, 1908			348

Respectfully submitted,

FRANK BAKER,
Secretary.

JANUARY 16, 1908.

TENTH ANNUAL REPORT OF THE TREASURER, 1907.

To the Washington Academy of Sciences:

The Treasurer has the honor to submit the following annual report of receipts, disbursements, and funds in his hands for the calendar year, 1907:

The receipts during the year were as follows:

Dues of life member		$ 100.00
Dues of resident members for 1905	$ 15.00	
Dues of resident members for 1906	105.00	
Dues of resident members for 1907	720.00	
Dues of resident members for 1908	15.00	855.00
Dues of non-resident members for 1904	10.00	
Dues of non-resident members for 1905	15.00	
Dues of non-resident members for 1906	75.00	
Dues of non-resident members for 1907	765.40	
Dues of non-resident members for 1908	10.00	
Dues of non-resident members for 1909	5.00	
Dues of non-resident members for 1910	5.00	
Dues of non-resident members for 1911	5.00	890.40
Sales of publications and refunds from authors for reprints, etc		123.00
Interest on bank deposit and investments		613.37
One half cost of publishing brochure pp. 275–522, Vol. IX, of Proceedings, paid by author		382.03
Reimbursements by Botanical and Biological Societies, shares of expenses celebration of 200th anniversary of Linnæus		25.00
Dividend on one share stock of Colonial Fire Insurance Co., on account of liquidation		60.00
Total receipts		$ 3,048.80

The amounts and objects of the expenditures were as follows:

Paid on account of expenses incurred in previous year, 1906:		
Meetings	$ 19.75	
Secretary's office	75.70	
Editor's office	500.00	
Publishing Vol. VIII of Proceedings	1133.06	$1,728.51

Paid on account of expenses of the past year, 1907:		
Meetings	$197.87	
Secretary's office	105.28	
Treasurer's office	124.12	
Rent of Cosmos Club hall	3.00	
Visit of International Zoölogical Congress	100.00	
Publishing Joint Directory	400.00	
Publishing Vol. IX of Proceedings	864.25	1,794.52
Total disbursements		$3,523.03

STATEMENT OF ACCOUNT.

Balance from last annual statement	1,174.74
Receipts during the year	3,048.80
To be accounted for	4,223.54
Disbursements during the year	3,523.03
Cash balance on hand	$ 700.51

Of this balance $255.09 belong to the permanent fund, leaving $445.42 available for general expenses.

The outstanding bills within the knowledge of the Treasurer are:

Editor's office	$500.00
Expenses of meetings	20.00
Expenses of Secretary's office	7.15
Publishing part of Vol. IX of Proceedings	764.07

and the completion and binding of Vol. IX.

Dues remain unpaid as follows:

For 1902	$ 10
For 1903	15
For 1904	20
For 1905	20
For 1906	50
For 1907	220
	$335

The investments are the same as stated in the last annual report, excepting the one share of stock of the Colonial Fire Insurance Co., par value $100, on which the company has paid $60, in connection with the liquidation of its affairs.

The investments are as follows:

Cash on hand belonging to permanent fund	$ 255.09
809 shares stock of Washington Sanitary Improvement Co.	8,090.00
2 shares stock of Scheutzen Park Land & Building	

Association, par value $100.00, actual value doubtful, say $44.00	$8.00
2 first trust notes of Laura R. Green, 5 per cent. interest, for $2,000 and $1,500	3,500.00
1 first trust note of Aurelius R. Shands, 4½ per cent. interest	444.44
	$12,377.53

The two notes of Laura R. Green are deposited with Thos. J. Fisher & Co., Washington, D. C., for collection of interest, and the remainder of the investments are in the Academy's safe deposit box at the Union Trust Company.

Respectfully submitted,

BERNARD R. GREEN,
Treasurer.

WASHINGTON ACADEMY OF SCIENCES

OFFICERS FOR 1908

President

CHARLES D. WALCOTT

Vice-Presidents

From the Anthropological Society.....W. H. HOLMES
Archæological Society.....JOHN W. FOSTER
Biological Society.....L. STEJNEGER
Botanical Society.....THOS. H. KEARNEY
Chemical Society.....F. W. CLARKE
Engineers Society.....ARTHUR P. DAVIS
Entomological Society.....A. D. HOPKINS
Foresters Society.....GIFFORD PINCHOT
Geographic Society.....WILLIS L. MOORE
Geological Society.....GEO. OTIS SMITH
Historical Society.....JAS. DUDLEY MORGAN
Medical Society.....HENRY D. FRY
Philosophical Society.....J. F. HAYFORD

Corresponding Secretary

FRANK BAKER

Treasurer

BERNARD R. GREEN

Recording Secretary

J. S. DILLER

Managers

Class of 1909

L. A. BAUER
C. HART MERRIAM
C. F. MARVIN

Class of 1910

GEO. M. KOBER
FREDERICK V. COVILLE
BAILEY WILLIS

Class of 1911

BARTON W. EVERMANN
L. O. HOWARD
O. H. TITTMANN

STANDING COMMITTEES FOR 1908.

Meetings

LEONHARD STEJNEGER, *Chairman*
J. S. DILLER
A. K. FISHER
E. B. ROSA
D. K. SHUTE

Finance

GEORGE OTIS SMITH, *Chairman*
S. S. ADAMS
BERNARD R. GREEN
C. L. MARLATT
GIFFORD PINCHOT

Rules

A. P. DAVIS, *Chairman*
F. W. HODGE
G. T. VAUGHAN

Functions

W. H. HOLMES, *Chairman*
CYRUS ADLER
F. W. CLARKE
WHITMAN CROSS
ALICE C. FLETCHER

Publication

BARTON W. EVERMANN, *Chairman*
L. J. BRIGGS
A. D. HOPKINS
C. HART MERRIAM
DAVID WHITE

Building

GEO. M. KOBER, *Chairman*
J. HOWARD GORE
J. A. HOLMES
WILLIS L. MOORE
H. W. WILEY

Affiliation

BAILEY WILLIS, *Chairman*
L. J. BRIGGS
F. E. WRIGHT

Membership

F. V. COVILLE, *Chairman*
ARNOLD HAGUE
L. O. HOWARD
A. F. A. KING
GEO. W. LITTLEHALES

MEMBERS OF THE WASHINGTON ACADEMY OF SCIENCES

JANUARY 17, 1908

PATRONS

Mr. Edward Henry Harriman, Arden, N. Y.

Mrs. Phoebe Apperson Hearst, Pleasanton, Cal.

Mrs. Henry Lee Higginson, 101 Commonwealth Ave., Boston, Mass.

Mrs. Gardiner Greene Hubbard, Woodley Lane, Washington, D. C.

Mr. Henry Cleveland Perkins, 1701 Conn. Ave., Washington, D. C.

Mr. Gifford Pinchot, 1615 Rhode Island Ave., Washington, D. C.

Mr. Thomas Francis Walsh, 2020 Massachusetts Ave., Washington, D. C.

RESIDENT MEMBERS

Abbe, Cleveland,
Weather Bureau.

Abbot, Chas. G.,
Smithsonian Institution.

Acker, Geo. N.,
913 16th Street, N. W.

Adams, Henry,
1603 H Street, N. W.

Adams, S. S.,
1 Dupont Circle.

Adler, Cyrus,
Smithsonian Institution.

Arnold, Ralph,
Smithsonian Institution.

Ashley, George H.,
Geological Survey.

Ashmead, William H.,
National Museum.

Bailey, Vernon,
Department of Agriculture.

Baker, Frank,
Zoölogical Park.

Bartsch, Paul,
Smithsonian Institution.

Bauer, L. A.,
Carnegie Institution.

Becker, G. F.,
Geological Survey.

Behrend, Edwin B.,
1214 K Street, N. W.

Bell, Alexander Graham,
1331 Connecticut Ave.

Bermann, I. S. L.,
Pennsylvania Ave. and Washington Circle.

Bigelow, Frank H.,
Weather Bureau.

Bovée, J. Wesley,
Conn. Ave. and H Street, N. W.

Briggs, Lyman J.,
Department of Agriculture.

Brooks, Alfred H.,
Geological Survey.

Bryan, Joseph H.,
1644 Connecticut Ave.

Burgess, George K.,
Bureau of Standards.

Casey, Thos. L.,
1419 K Street, N. W.

Chesnut, V. K.,
Department of Agriculture.

Clarke, F. W.,
Geological Survey.

Cook, G. Wythe,
3 Thomas Circle, N. W.

Cook, O. F.,
Department of Agriculture.

Coquillett, D. W.,
National Museum.

Coville, Frederick V.,
Department of Agriculture.

Cross, Whitman,
Geological Survey.

Crozier, William,
Ordnance Office.

Cushman, Allerton S.,
1751 N Street, N. W.

Darton, N. H.,
Geological Survey.

Davis, A. P.,
Reclamation Service.

Day, Arthur L.,
Carnegie Institution.

Day, David T.,
2511 Cliffbourne Street.

Diller, J. S.,
Geological Survey.

Dyar, Harrison G.,
National Museum.

Eichelberger, William S.,
Naval Observatory.

Eimbeck, William,
Hotel Montrose, 14th and H Street N. W.

Emmons, S. F.,
Geological Survey.

Evermann, Barton W.,
Bureau of Fisheries.

Fisher, A. K.,
Department of Agriculture.

Fletcher, Alice C.,
214 1st Street, S. E.

Fletcher, Robert,
Army Medical Museum.

Flint, James M.,
National Museum.

Foster, John W.,
1323 18th Street, N. W.

French, William B.,
506 East Capitol Street.

Fry, Henry D.,
1601 Connecticut Ave.

Gallaudet, E. M.,
Kendall Green, N. E.

Gannett, Henry,
Geological Survey.

Gannett, Samuel S.,
2556 University Place.

Garriott, E. B.,
Weather Bureau.

Gilbert, G. K.,
Geological Survey.

Gill, Theodore,
Smithsonian Institution.

Gore, J. Howard,
George Washington University.

Green, Bernard R.,
Library of Congress.

Greene, Edward L.,
National Museum.

Hague, Arnold,
Geological Survey.

Hall, Asaph, Jr.,
Naval Observatory.

Harris, R. A.,
Coast Survey.

Harris, W. T.,
1360 Fairmont Street, N. W.

Hay, W. P.,
Western High School.

Hayes, C. W.,
Geological Survey.

Hayford, John F.,
Coast and Geodetic Survey.

Henry, A. J.,
Weather Bureau.

Henshaw, Henry W.,
Biological Survey.

Hickling, D. P.,
1304 Rhode Island Ave., N. W.

Hodge, F. W.,
Smithsonian Institution.

Holmes, J. A.,
Geological Survey.

Holmes, W. H.,
Bureau of American Ethnology.

Hopkins, A. D.,
Bureau of Entomology.

Howard, L. O.,
Department of Agriculture.

Hyde, John,
1840 Summit Place.

Johannsen, Albert,
Geological Survey.

Johnson, Jos. Taber,
926 17th Street, N. W.

Jung, F. A. R.,
1229 Connecticut Ave.

Kearney, T. H.,
Bureau of Plant Industry.

Keith, Arthur,
Geological Survey.

Kendall, William C.,
Bureau of Fisheries.

Kimball, H. H.,
2235 13th Street, N. W.

King, A. F. A.,
1315 Massachusetts Ave., N. W.

Knowlton, F. H.,
National Museum.

Kober, George M.,
1819 Q Street, N. W.

Lamb, D. S.,
Army Medical Museum.

Langworthy, C. F.,
Department of Agriculture.

Lindgren, W.,
The Cecil.

Littlehales, G. W.,
Hydrographic Office, Navy Department.

Magruder, G. L.,
Stoneleigh Court.

Marlatt, C. L.,
Department of Agriculture.

Marsh, M. C.,
Bureau of Fisheries.

Marvin, C. F.,
Weather Bureau.

Matthes, F. E.,
Geological Survey.

Maxon, Wm. R.,
National Museum.

Merriam, C. Hart.,
1919 16th Street, N. W.

Metzerott, John H.,
1110 F Street, N. W.

Moore, Willis L.,
Weather Bureau.

Moran, John F.,
2426 Pennsylvania Ave., N. W.

Morgan, James Dudley,
919 15th Street, N. W.

Munroe, Chas. E.,
George Washington University.

Nelson, E. W.,
Department of Agriculture.

Newell, F. H.,
Reclamation Service.

Nordhoff-Jung, Sofie A.,
1229 Connecticut Ave.

Oberholser, Harry C.,
Department of Agriculture.

Osgood, Wilfred H.,
Department of Agriculture.

Palmer, T. S.,
Department of Agriculture.

Parker, Edward W.,
Geological Survey.

Pinchot, Gifford,
Forest Service.

Prindle, L. M.,
Geological Survey.

Putnam, G. R.,
Coast Survey.

Ransome, Frederick L.,
1455 Belmont Street.

Rathbun, Mary J.,
National Museum.

Rathbun, Richard,
Smithsonian Institution.

Reyburn, Robert,
714 13th Street, N. W.

Richardson, Chas. W.,
1317 Connecticut Ave.

Richardson, Harriet,
National Museum.

Richmond, C. W.,
Smithsonian Institution.

Ridgway, Robert,
Smithsonian Institution.

Rosa, E. B.,
Bureau of Standards.

Rose, J. N.,
National Museum.

Ruffin, Sterling,
1335 Connecticut Ave.

Safford, William E.,
Department of Agriculture.

Schaller, Waldemar T.,
Geological Survey.

Schrader, J. C.,
1327 R Street, N. W.

Schwarz, E. A.,
National Museum.

Searle, George M.,
Catholic University of America.

Shands, A. R.,
901 16th Street, N. W.

Shute, D. K.,
1719 De Sales Street.

Smith, George Otis,
Geological Survey.

Smith, Hugh M.,
Bureau of Fisheries.

Spillman, W. J.,
Department of Agriculture.

Spofford, A. R.,
Library of Congress.

Stanton, T. W.,
National Museum.

Steiger, George,
1338 Fairmont Street, N. W.

Stejneger, L.,
National Museum.

Sternberg, George M.,
2005 Massachusetts Ave., N. W.

Stevenson, Mrs. Matilda C.,
Bureau of Ethnology.

Stratton, Samuel W.,
The Farragut.

Sudworth, George B.,
Forest Service.

Tittmann, O. H.,
Coast Survey.

True, F. W.,
National Museum.

Tweedy, Frank,
Geological Survey.

Ulrich, Edward O.,
Geological Survey.

Van Rensselaer, John,
The Rochambeau.

Vaughan, George T.,
1718 I Street, N. W.

Vaughan, Thomas Wayland,
Smithsonian Institution.

Waidner, Chas. Wm.,
Bureau of Standards.

Walcott, Chas. D.,
Smithsonian Institution.

Warman, Philip C.,
3345 17th Street, N. W.

Wead, Chas. K.,
Patent Office.

Webster, F. M.,
Bureau of Entomology.

Weeks, F. B.,
Geological Survey.

Wells, Walter A.,
The Rochambeau.

White, David,
National Museum.

White, Wm. A.,
Gov't Hospital for the Insane.

Wiley, H. W.,
Department of Agriculture.

Willis, Bailey,
Geological Survey.

Wilmer, W. H.,
1610 I Street, N. W.

Woods, A. F.,
Department of Agriculture.

Woodward, R. S.,
Carnegie Institution of Washington.

Woodward, Wm. C.,
508 I Street, N. W.

Wright, Fred E.,
Geological Survey.

Wyman, Walter,
Marine Hospital Bureau.

Zahm, A. F.,
Catholic University of America.

Non-Resident Members

Adams, Frank D.,
McGill University, Montreal, Canada.

Alexander, W. D.,
P. O. Box 732, Honolulu, H. I.

Allen, J. A.,
American Museum of Natural History, New York City.

Allen, Wm. F.,
Pacific Grove, Calif.

Allen, Wm. F.,
180 Scotland Road, South Orange, N. J.

Andrews, Ethan A.,
Johns Hopkins University, Baltimore, Md.

Arthur, J. C.,
Purdue University, Lafayette, Ind.

Bancroft, W. D.,
Cornell University, Ithaca, N. Y.

Bangs, Outram,
20 Pemberton Square, Boston, Mass.

Bascom, Florence,
Bryn Mawr College, Bryn Mawr, Pa.

Baskerville, Charles,
College of the City of New York, New York City.

Batchelder, Charles Foster,
7 Kirtland Street, Cambridge, Mass.

Beardsley, A. E.
State Normal School, Greeley, Colo.

Benedict, Francis Gano,
Middletown, Conn.

Bessey, C. E.,
University of Nebraska, Lincoln, Nebraska.

Birge, E. A.,
State University, Madison, Wis.

Birnie, Rogers,
Ordnance Dept. U. S. A., Governor's Island, New York City.

Bixby, W. H.,
508 Federal Building, Chicago, Ill.

Blunt, Stanhope E.,
Springfield Armory, Springfield, Mass.

Branner, John C.,
Stanford University, Calif.

Brewster, William,
145 Brattle Street, Cambridge, Mass.

Buckley, Ernest R.,
Rollo, Mo.

Campbell, Douglas H.,
Stanford University, Calif.

Cattell, J. McKeen,
Garrison-on-Hudson, N. Y.

Chamberlin, T. C.,
University of Chicago, Chicago, Ill.

Chandler, C. F.,
Columbia University, New York City.

Clark, William B.,
Johns Hopkins University, Baltimore, Md.

Cohen, S. Solis,
1525 Walnut Street, Philadelphia, Pa.

Coleman, Arthur Philemon,
School of Science, Toronto, Ontario, Canada.

Conner, P. S.,
215 W. 9th Street, Cincinnati, Ohio.

Coulter, John M.,
University of Chicago, Chicago, Ill.

Cox, Ulysses O.,
State Normal School, Terre Haute, Indiana.

Dana, E. S.,
24 Hillhouse Ave., New Haven, Conn.

Davenport, Chas. B.,
Cold Spring Harbor, New York.

Dike, Samuel W.,
113 Hancock Street, Auburndale, Mass.

Dudley, C. B.,
Drawer 334, Altoona, Pa.

Dunham, E. K.,
338 East 26th Street, New York City.

Eastman, J. R.,
Andover, N. H.

Edwards, Charles L.,
Hartford, Conn.

Eigenmann, Carl H.,
650 Atwater Ave., Bloomington, Ind.

Eliot, Charles W.,
Harvard University, Cambridge, Mass.

Elliot, Daniel G.,
American Museum of Natural History, New York City.

Emerson, B. K.,
Amherst College, Amherst, Mass.

Evans, Alex. W.,
2 Hillhouse Ave., New Haven, Conn.

Farnham, H. W.,
43 Hillhouse Ave., New Haven, Conn.

Faxon, Walter,
Museum of Comparative Zoölogy, Cambridge, Mass.

Fisher, Irving,
Yale University, New Haven, Conn.

Forbes, S. A.,
University of Illinois, Urbana, Ill.

Forscheimer, Frederick,
The Ortig, 4th and Sycamore Streets, Cincinnati, Ohio.

Frankforter, G. B.,
Minneapolis, Minn.

Freer, Paul C.,
Bureau of Science, Manila, P. I.

Gage, Simon H.,
Cornell University, Ithaca, N. Y.

Garman, Samuel,
Museum of Comparative Zoölogy, Cambridge, Mass.

Garrison, George P.,
2600 White's Avenue, Austin, Texas.

Gilbert, Charles H.,
Stanford University, Calif.

Gilman, Daniel C.,
614 Park Ave., Baltimore, Md.

Glenn, L. C.,
Vanderbilt University, Nashville, Tenn.

Goodale, George L.,
Harvard University, Cambridge, Mass.

Gorham, F. P.,
Brown University, Providence, R. I.

Graves, Henry S.,
Yale School of Forestry, New Haven Conn.

Gray, Thomas,
Rose Polytechnic Institute, Terre Haute, Ind.

Greene, Chas. W.,
University of Missouri, Columbia, Mo.

Grinnell, Geo. Bird,
346 Broadway, New York City.

Guthe, Karl E.,
State University of Iowa, Iowa City, Iowa.

Hale, G. E.,
Solar Observatory, Pasadena, Calif.

Halsted, Geo. B.,
Box 68, Greeley, Colo.

Halsted, Wm. S.,
1201 Eutaw Street, Baltimore, Md.

Hargitt, Charles W.,
809 Walnut Ave., Syracuse, N. Y.

Heath, Harold,
Stanford University, Calif.

Herter, C. A.,
819 Madison Ave., New York City.

Hilgard, E. W.,
Berkeley, Calif.

Hitchcock, C. H.,
Dartmouth College, Hanover, N. H.

Howe, James Lewis,
Washington and Lee University, Lexington, Va.

Humphreys, W. J.,
Mount Weather, Va.

Iddings, J. P.,
University of Chicago, Chicago, Ill.

Irving, John D.,
Lehigh University, South Bethlehem, Pa.

Jacobi, Abraham,
110 West 34th Street, New York City.

Jenkins, Oliver P.,
Stanford University, Calif.

Jordan, David Starr,
Stanford University, Calif.

Kahlenberg, Louis,
306 Lake Street, Madison, Wis.

Keen, W. W.,
College of Physicians, 219 South 13th Street, Philadelphia, Pa.

Kelley, Howard A.,
1406 Eutaw Place, Baltimore, Md.

Kellogg, Vernon L.,
Stanford University, Calif.

Kemp, James F.,
Columbia University, New York City.

Kingsley, J. S.,
Tufts College, College Hill, Mass.

Klotz, Otto J.,
Department of the Interior, Ottawa, Canada.

Lefevre, George,
University of Missouri, Columbia, Mo.

Linton, Edward,
400 East Madison Street, Washington, Pa.

Long, J. H.,
7748 Sangamon Street, Chicago, Ills.

Longstreet, Morris,
1418 Spruce Street, Philadelphia, Pa.

McAdie, A. G.,
U. S. Weather Bureau, San Francisco, Calif.

McGee, W J,
4137 Lindell Boulevard, St. Louis, Mo.

Macfarlane, Alexander,
Chatham, Ontario, Canada.

Mallet, J. W.,
University of Virginia, Charlottesville, Va.

Matthews, Edward B.,
Assistant State Geologist, Baltimore, Md.

Mead, A. D.,
Brown University, Providence, R. I.

Meek, S. E.,
Field Museum of Natural History, Chicago, Ill.

Merriam, John C.,
2401 Bowditch Street, Berkeley, Calif.

Miller, W. Lash,
50 St. Albans Street, Toronto, Canada.

Moore, Clarence B.,
1321 Locust Street, Philadelphia, Pa.

Moore, George T.,
West Chester, Pa.

Morley, E. W.,
West Hartford, Conn.

Morse, H. N.,
Johns Hopkins University, Baltimore, Md.

Mottier, David M.,
Indiana University, Bloomington, Ind.

Münsterberg, Hugo,
7 Ware Street, Cambridge, Mass.

Muir, John,
Martinez, Calif.

Nachtrieb, Henry F.,
University of Minnesota, Minneapolis, Minn.

Northrop, Cyrus,
University of Minnesota, Minneapolis, Minn.

Nutting, C. C.,
University of Iowa, Iowa City, Iowa.

Ortmann, A. E.,
Carnegie Museum, Shenley Park, Pittsburg, Pa.

Osborn, H. F.,
American Museum of Natural History, New York City.

Pammel, L. H.,
Agricultural College, Ames, Iowa.

Parker, Geo. H.,
16 Berkeley Street, Cambridge, Mass.

Paul, H. M.,
50 Rodgers Row, Annapolis, Md.

Peirce, Benj. Osgood,
Harvard University, Cambridge, Mass.

Pickering, Edward C.,
Harvard University Observatory, Cambridge, Mass.

Pirsson, L. V.,
Yale University, New Haven, Conn.

Pratt, J. F.,
Coast Survey, Manila, P. I.

Prosser, Charles S.,
University of Ohio, Columbus, Ohio.

Putnam, F. W.,
Peabody Museum, Cambridge, Mass.

Raymond, C. W.,
1 West 34th Street, New York City.

Reed, H. D.,
Cornell University, Ithaca, N. Y.

Reid, H. F.,
Johns Hopkins University, Baltimore, Md.

Remsen, Ira,
Johns Hopkins University, Baltimore, Md.

Rice, Wm. North,
Wesleyan University, Middletown, Conn.

Richards, Mrs. Helen H.,
Massachusetts Institute of Technology, Boston, Mass.

Richards, Theodore W.,
15 Follen Street, Cambridge, Mass.

Richardson, Clifford,
122 East 34th Street, New York City.

Rising, W. B.,
University of California, Berkeley, Calif.

Ritter, William E.,
2434 Durant Avenue, Berkeley, Calif.

Robinson, Benj. L.,
Gray Herbarium, Cambridge, Mass.

Rotch, A. Lawrence,
742 Exchange Building, Boston, Mass.

Russell, H. L.,
University of Wisconsin, Madison, Wis.

Rutherford, E.,
Physical Laboratory, University, Manchester, England.

Salisbury, Rollin D.,
University of Chicago, Chicago, Ill.

Sargent, C. S.,
Brookline, Mass.

Scott, W. B.,
Princeton, N. J.

See, Thomas J. J.,
Mare Island Navy Yard, Vallejo, Calif.

Setchell, W. A.,
University of California, Berkeley, Calif.

Shattuck, Frederick C.,
135 Marlborough Street, Boston, Mass.

Sherman, Frank A.,
Dartmouth College, Hanover, N. H.

Slonaker, J. Rollin,
Stanford University, Calif.

Smith, John B.,
Rutgers College, New Brunswick, N. J.

Spurr, J. E.,
71 Broadway, New York City.

Stearns, Robert E. C.,
1025 East 18th Street, Los Angeles, Calif.

Stengel, Alfred,
1811 Spruce Street, Philadelphia, Pa.

Stevenson, J. J.,
University Heights, New York City.

Stockton, Charles G.,
436 Franklin Street, Buffalo, N. Y.

Stone, Osmond,
University of Virginia, Charlottesville, Va.

Sumner, F. B.,
Woods Hole, Mass.

Thayer, William S.,
406 Cathedral Street, Baltimore, Md.

Thiessen, A. H.,
Local Office, Weather Bureau, Raleigh, N. C.

Toumey, J. W.,
459 Prospect Street, New Haven, Conn.

Townsend, Charles H.,
New York Aquarium, Battery Park, New York City.

Van Hise, Charles R.,
University of Wisconsin, Madison, Wis.

Wadsworth, F. L. O.,
Morgantown, W. Va.

Washington, Henry S.,
Locust, N. J.

Webber, Herbert J.,
Cornell University, Ithaca, N. Y.

Weed, Walter H.,
42 Broadway, New York City.

Wheeler, William M.,
American Museum of Natural History, New York City.

White, Israel C.,
Morgantown, West Va.

Whitfield, R. P.,
American Museum of Natural History, New York City.

Willcox, W. F.,
Wellesley College, Wellesley, Mass.

Williams, H. S.,
Cornell University, Ithaca, N. Y.

Williams, Leonard W.,
Harvard Medical School, Boston, Mass.

Williams, Talcott,
916 Pine Street, Philadelphia, Pa.

Wilson, H. V.,
University of North Carolina, Chapel Hill, N. C.

Wilson, J. C.,
1509 Walnut Street, Philadelphia, Pa.

Wilson, W. P.,
233 South 4th Street, Philadelphia, Pa.

Woodworth, William McMichael,
Museum of Comparative Zoölogy, Cambridge, Mass.

Worcester, Dean C.,
Manila, P. I.

Wright, Arthur W.,
73 York Square, New Haven, Conn.

Wright, Carroll D.,
Clark University, Worcester, Mass.

Ziwet, Alexander,
University of Michigan, Ann Arbor Mich.

INDEX.

NOTE. — New names in **black-face type**, synonyms in *Italics*.

abnorme, Chilometopon 373, 375, 376
  Eurymetopon 288
  Metoponium 291
abnormis, Trimytis 367
Acanthorhiza 175
acomanus, Bothrotes 407
acuminatus, Melanastus 362
acuticauda humeralis, Polemiotus 383
acutus, **Bothrotes** 399
  Epitragus 399
  Melanastus 362
Adelostoma 282
Adelostomini 281
Adesmia 277
Adesmiini 280
ænicollis, Bothrotes 401
æneopiceum, Lobometopon 390
æqualis, Nosoderma 470
æquicollis, Melanastus 360
æquicollis, Nyctoporis 512
æquipenne, Lobometopon 393
affinis, Bothrotes 405
alatus, Emmenastus 514
aliena, Telabis 325
Allen, Wm. F. 79
alutaceus, Steriphanus 348
alveolatum, Lobometopon 394, 397
ambiguus, Emmenastus 515
American Components of the Tentyriinæ 275
amica, Telabis 318
amplexa, Metopoloba 418
amplificans, Bothrotes 410
amplipenne, Prometopion 366, 372
Anatolica 431
anceps, Metoponium 294
Anepsius 282, 501, 503
  atratus 506
  bicolor 507
  brunneus 506
  catenulosus 505
  deficiens 507
  delicatulus 501, 506
  montanus 505
  nebulosus 507
  valens 504
Angiosperms, Origin and Evolution of 159
angularis, Armalia 331
angulata, Metopoloba 419
angusticollis, Edrotes 452
angustulus, Edrotes 456
angustus, Cnemodus 283, 284
angustus, **Hylocrinus** 335
annulatipes, Noserinus 470
  Philœodes 471
Anthoceros, not representative of ancestral Pteridophyte 161
  vegetative capsule of, described 160
Apospory, defined 159
  Origin and Evolution of Angiosperms through 159
  relation to Apogamy 160
Arœoschizini 281, 484
Arœoschizus 282, 485
  armatus 490
  costipennis 485, 486
  decipiens 490
  duplicatus 491
  exiguus 487
  fimbriatus 487
  mexicanus 485
  regularis 489
  sulcicollis 488
  simplex 489
  simulans 488
  tenuis 486
Archidium 164
aridus, Sterophanus 351
arizonicum, Metoponium 294
Armalia 289, 330, 331, 339
  angularis 331
  texanus 331
armatus, Arœoschizus 490
arundinis, **Bothrotes** 401
Asida 312
Asidinæ 500
Asidini 500
aspera, Telabis 322
Atavism 202
ater, Emmenastus 289
  Melanastus 355
atratus, Anepsius 506
atratus, Tydoleus 380
Auchmobiini 278, 365
Auchmobius 277, 365
  sublævis 365, 366
aurulentus, Epitragus 518

Batuliini 282, 497
Batuliodes 497, 498, 499
  rotundicollis 497, 500
Batulius 497, 498
  setosus 497, 499
basalis, Schenicus 428
basalis, Triorophus 437
Begonia 167, 172, 175
belli, Emmenastus 514
bicaviceps, Lobometopon 394, 397
bicolor, Anepsius 507
bicolor, **Metoponium** 311

bicostata, Cryptoglossa 503
bifossiceps, Metopoloba 413
blaisdelli, Hylocrinus 336
blanda, Telabis 326
Blapstinus 290, 353, 364
Boletophagus obcordatus 470
Bothrotes 379, 398
acomanus 407
acutus 399
ænicollis 401
affinis 405
amplificans 410
arundinis 401
canaliculatus 408
chalceus 402
confertus 404
eversus 404
fortis 399
funebris 409
insitus 408
knausi 401
neglectus 407
obsolescens 411
occipitalis 403
pensus 400
perditus 409
pertinax 405
picipennis 406
secutor 406
secutor apertus 406
subrudis 400
tenebrosus 403
brevicolle, Eurymetopon 327, 514
brevicollis, Eunotiodes 519, 520
brevicollis, Nosoderma 478, 479
brevipenne, Chilometopon 374
brevipennis, Emmenastus 514
brevis, Triorophus 439
breviusculus, Hylocrinus 334
brunnescens, Hylocrinus (Locrodes) 338
brunneus, Anepsius 506
Bryophyllum 167, 172, 175
Buxbaumia 163

californica, Metopoloba 419
californicus, Zopherodes 466
canaliculatus, **Bothrotes** 408
canaliculatus, Emmenastus 514
canaliculatus, Epitragus 379
candidum, Metoponium 292
Capnisa 282, 521
Capnisini 279
caraboides, Centrioptera 502
carbonatum, **Metoponium** 297
carinata, Nyctoporis, 511
Casey, Thos. L. 275
castaneum, Chilometopon 373, 376
Castilla 174
catenulosus, Anepsius 505
cavicauda, Cyrtomius, 379, 384, 385
Centrioptera 502, 513
caraboides 502
utensis 513
Cereus 176
chalceus, Bothrotes 402
chalybeus, Schenicus 428
championi, Ditaphronotus 342
Nosoderma 476
chevrolati, Epitragus 397
chilensis, Zopherus 461
Chilometopon, 277, 366, 367, 370, 372, 375
abnorme 373, 375, 376
brevipenne 374, 376
castaneum 373, 376
ensifer 374, 375
pallidum 375
chiriquensis, Emmenastus 514
Cnemodini 278, 283
Cnemodus 282, 283, 284
angustus 283, 284
subhyalinus 285
testaceus 284
coarcticollis, Melanastus 361
cognitum, Metoponium 305
Coleoptera 276
communis, **Lobometopon** 397
compactus, Emmenastus 287
compar, Telabis 321
concors, Metoponium 305
confertus, Bothrotes 404
congener, **Metoponium** 302
congruens, Metoponium 293
conicicollis, Emmenastus 289
conicicollus, **Steriphanus** 349
Conionotis 365
Conjugates 195
Conjugate and Exjugate Reproduction 193
conjugate hybridism 215
organisms 195, 197
reversion 212
Conœcus 277, 378, 380, 429
estriatus 431
ovipennis 380, 431
constrictus, Emmenastus 330, 576
contaminans, Metopoloba 418
convexicolle, **Metoponium** 310
convexulus, Noserus 474
convexus, **Steriphanus** 346
Cook, O. F. 159, 189
corrosus, Noserus 474
costipennis, Araeoschizus 485, 486
Craniotini 280, 457
Craniotus 276, 277, 458, 459
pubescens 458, 459
crassicornis, **Melanastus** 360
crassula, Telabis 320, 326
crassum, Metoponium 299
cribratus, Emmenastrichus 341
Emmenastus 289
cribriceps, Metoponium 305
cribricolle, Lobometopon 391
cribricollis, Triphalus 448
cristata, Nyctoporis 502, 510
Cryptadius 288, 327, 352
curvipes 329
inflatus 288, 328
oviformis 328, 329
punctipennis 328
Cryptoglossa 503, 513
bicostata 503
Cryptoglossini 513
cunctans, Hylocrinus 336
cuprascens, Epitragodes 424
curticollis, Telabis 321
curtus, Emmenastus 515
curvipes, Cryptadius 329

Cyathodium, relation to Riella 161
relation to Sphærocarpus 161
cylindricum, **Metoponium** 306
Cyrtomius 379, 383
cavicauda 379, 384, 385
dentiger 384, 385
inequalis 385
plicatus 384, 385

Dacoderini 281, 491
Dacoderus 341, 493
striaticeps 493, 494
Dailognatha, 521
Davenport, Charles B. 179
debilicollis, Epitragodes 423
debilis, Telabis 320
decipiens, Aræoschizus 490
deficiens, Anepsius 507
delicatulus, Anepsius 501, 506
delicatulus, Hylocrinus 334
denticulata, *Nosoderma* 469
dentiger, Cyrtomius 384, 385
depressicornis, Gnathosia 287
depressulus, Hylocrinus 335
descent, intermediate 214
Primary methods of 198
Synopsis of methods of 199
Desmoncus 174
diabolica, *Nosoderma* 469
Dichillus 282
difficilis, *Schœnicus* 428
dimorphism, semisexual 205
sexual 205
subsexual 206
supersexual 207
Dioscorea 175
discors, Telabis 313
discrepitans, Steriphanus 343
discretus, Steriphanus 350
Ditaphronotus 289, 341
championi 342
docile, Lobometopon 390
dominance, partial 209
dormeanum, Phlœodes 471
dorsiventris, Metopoloba 417
dubium, **Metoponium** 301
duplicatus, Aræoschizus 491
duponcheli, *Nosoderma* 470

edax, Metoponium 309
Edrotes 277, 450
angusticollis 452
angustulus 456
globosus 454
inflatus 454
intermixtus 455
lineatus 456
longipennis 453
nitidus 452
oblongulus 455
orbus 452
puncticeps 454
rotundus 453
subæqualis 456
ventricosus 450, 451
Edrotini 279, 282, 449
egregium, Metoponium 300
Electrolytic Migration, Experimental Data of 1
elliptica, *Emmenastus* 515
elongatus, Zopherodes 406
emarginatum, **Metoponium** 304
Emmenastrichus 289, 340
cribratus 341
crosus 341
Emmenastus 287, 343
alatus 514
ambiguus 515
ater 289
belli 514
brevipennis 514
canaliculatus 514
chiriquensis 514
compactus 287
confusus 342
conicicollis 289
constrictus 330, 516
cribratus 289
curtus 515
ellipticus 515
foveicollis 289, 342, 51
glabratus 515
guatemalensis 515
igualensis 516
intermedius 514
levicollis 342, 515
lentus 515
longicornis 514
longulus 289
mancus 515
mexicanus 515
parallelus 515
picipes 515
pinguis 289
pulvinatus 515
punctatus 289
rotundicollis 514
rugicollis 515
rugosus 287
salvini 514
seriatus 515
solitarius 514
stolidus 515
subapterus 515
tenebrosus 515
texanus 289
variabilis 514
vicinus 515
Emmenides 289, 329, 516
punctatus 330
enorme, Eurymetopon 286
ensifer, Chilometopon 374, 37
Epiphysa 277
Epiphysini 282
Epitragini 278, 282, 378
Epitragodes 380, 420, 421
cuprascens 424
debilicollis 423
floridanus 424
julichi 380, 427
macilentus 425
obesulus 425
pardalis 423
tomentosus 423
(**Epitragoma**) 386, 396, 397
(**Epitragopsis**) 386, 396, 518
Epitragus 378, 381, 385, 396, 518
acutus 399
aurulentus 518

canaliculatus 379
chevrolati 397
fuscus 378, 518
fusiformis 379
godmani 518
grandis 383
pilosus 397
plumbeus 395
pruinosus 379, 417
ovalis 395
rigens 381, 518
sallei 381
submetallicus 379
tomentosus 380, 423
vestitus 396
equipolar inheritance 208
Erodiini 280
Erodius 282
erosus, Emmenastrichus 341
estriatus, Concœcus 431
Eucalyptus 172
Eunotiodes 519
brevicollis 519, 520
Eutogenia 282
Eurychora inæqualis 470, 475
Eurymetopon 286, 287, 288, 289, 326
abnorme 288
brevicolle 327, 514
enorme 286
rufipes 286, 288, 326
Eurymetoponini 278, 285, 287
eversus, Bothrotes 404
exiguus, Arœoschizus 487
Melanastus 363
exoletus, Melanastus 356
Experimental data of Electrolytic Migration 1
Experiments in Descent, Nature of 191
exsculpta, Nosoderma 479
extensum, Metoponium 300
extrapolar inheritance 211

fallax, **Melanastus** 359
famelica, Telabis 323
farctus, Omopheres 519, 521
fatigans, Metoponium 304
faustum, Metoponium 292
Ficus 174
fidelis, Telabis 320
filitarsus, Hylocrinus 333
fimbriatus, Arœoschizus 487
finitimus, Melanastus 359
flohri, **Tlascalinus** 370
floridanus, Epitragodes 424
fortis, Bothrotes 399
foveicollis, Emmenastus 289, 342, 575
fraternus, Hylocrinus (Locrodes) 338
funebris, Bothrotes 409
fusculum, Metoponium 298
fuscus, Epitragus 378, 518
fusiformis, Epitragus 379

galeata, Nyctoporis 510
geminatus, Zopherodes 467
glabratus, Emmenastus 515
globosus, Edrotes 454
Gnathosia 431, 521
depressicornis 287
Gnathosini 279, 282
godmani, Epitragus 518
godmani, **Lobometopon** 396, 397
gracilicornis, Triorophus 437
grandiceps, Oxygonodera 446
grandis, Epitragus 383
gravidulus, Triorophus 437
gravidum, Metoponium 308
Greene, Edward L. 241
guatemalensis, Emmenastus 575
Nosoderma 481
gulosum, Metoponium 307

hebes, Metoponium 301
Heredity, 201
and Mendel's Law 179
helopioides, **Prometopion** 371, 372
Hemasodes 378, 381
Heterism 200
hilaris, Steriphanus 345
Himatismus 282
hispidula, **Oxygonodera** 445
hispidula, Stibia 445
histrica, Telabis 317, 326
histrio, Triorophus 437
Houstonia, semisexual dimorphism in 206
humeralis, Polemiotus 382, 383
hybridism 214
conjugate 215
perjugate 215
Hylithus 282
Hylocrinus 289, 331, 332
angustus 335
blaisdelli 336
breviusculus 334
cunctans 336
delicatulus 334
depressulus 335
filitarsus 333
(Locrodes) brunnescens 338
(Locrodes) fraternus 338
(Locrodes) laborans 337, 339
(Locrodes) oblongulus 337
(Locrodes) piceus 336
(Locrodes) umbrosus 338
longulus 333, 339
(Paravius) marginatus 339
piceus 326
tenuis 333
Hyperops 282

igualensis, Emmenastus 516
ignava, Trimytis 369
implicans, Melanastus 358
impressus, Schenicus 428
inæqualis, Eurychora 470, 475
Mesabates 517
inæqualis, **Mesabatodes** 517
Nosoderma 476
incisa, Telabis 322, 326, 327
incrustans, Zopherodes 464
inflatus, Cryptadius 288, 328
inflatus, Edrotes 454
inheritance, equipolar 208
extrapolar 211
intergraded 203
interpolar 211
mosaic 211
polar 204
scalar 203

Inodes 174
inops, Telabis 325
insitus, Bothrotes 408
insulare, Metoponium 308
integer, Metoponium 310
intergraded inheritance 203
intermediate descent 214
intermedius, Emmenastus 514
intermixtus, Edrotes 455
interpolar inheritance 211

jucundum, Lobometopon 392
julichi, Epitragodes 380, 427
jülichi, Phegoneus 427

knausi, Bothrotes 401

laborans, Hylocrinus (Locrodes) 337, 339
lacerta, Usechus 482, 483
lævicollis, Emmenastus 342, 515
lævis, Triorophus 432, 435
lamarckiana, Œnothera 209
lata, Œnothera 209
laticolle, Metoponium 291
latifrons, Mesabates 516
lecontei, Triorophus 439
lentus, Emmenastus 515
Lepisosteidæ 80
Lepisosteus osseus 80
platostomus 80
tristœchus 80
Leptodini 280
libertus, Steriphanus 350
limbatus, Zopherinus 461
Linnæan Memorial Address 241
lineatus, Edrotes 456
lobifrons, Telabis 318, 326
Lobometopon 379, 385, 386, 396, 397
aberrans 387
æneopiceum 390
æquipenne 393
alveolatum 394, 397
bicaviceps 394, 397
communis 397
cribricolle 391
docile 390
fusiforme 388
godmani 386, 396
gracile 387
jucundum 392
morrisoni 393
obscurum 396
ovale 395
parvicolle 392
pimalicum 389
plumbeum 395
propinquum 391
symmetricum 389
uintanum 388
vestitum 396
Locrodes 332, 336, 339
longicornis, Emmenastus 514
longicornis, Triorophus 438
longipennis, Edrotes 453
longipennis, Nosoderma 477, 479
longipennis, Telabis 288, 313, 327
longulus, Emmenastus 289
longulus, Hylocrinus 333, 339
lubricans, Steriphanus 345
lucidulus, Melanastus 358
ludificans, Metoponium 303
ludius, Melanastus 361
lustrans, Steriphanus 341
lustrella, Telabis 323
Lythrus, trimorphism in 206

macilentus, Epitragodes 425
Mammillaria 176
mancus, Emmenastus 515
Marchantiaceæ, relation to Pteridophyta 161
marginatus, **Hylocrinus (Paravius)** 339
maritima, Stibia 442
maritimus, Micromes 442, 443
maura, Nyctoporis 512
McBain, James W. 1
Megazopherus 461
Melanastus 289, 353, 354, 361
acuminatus 362
acutus 362
æquicollis 360
ater 355
coarcticollis 361
crassicornis 360
exiguus 363
exoletus 356
fallax 359
finitimus 359
implicans 358
lucidulus 358
ludius 361
mœstus 355
nitidus 355
nuperus 364
obesus 363
obtusus 356
otiosus 358
parvus 362
sonoricus 364
sterilis 357
thoracicus 356
vegrandis 360
Melanestes 287
Melocanna 173
Mendelism 210
and Other Methods of Descent 189
as a Method of Descent 198
evolutionary implications of 232
relation to normal diversity 230
Meralius 470
Mesabates 516
inæqualis 517
latifrons 516
spissicornis 517
Mesabatodes inæqualis 517
Mesembryanthemum 176
Metopoloba 379, 412
amplexa 418
angulata 419
bifossiceps 413
californica 419
contaminans 418
dorsiventris 417
perpolita 415
proba 414
pruinosa 417
punctiventris 414
snowi 416
sublæviceps 418
subseriata 415

Metoponiopsis 290, 329
Metoponium 288, 289
abnorme 291
anceps 294
arizonicum 294
bicolor 311
candidum 292
carbonatum 297
cognitum 305
concors 305
congener 302
congruens 293
convexicolle 310
crassum 299
cribriceps 305
cylindricum 306
dubium 301
edax 309
egregium 300
emarginatum 304
extensum 300
fatigans 304
faustum 292
fusculum 298
gravidum 308
gulosum 307
hebes 301
insulare 308
integer 310
laticolle 291
ludificans 303
molestum 309
nevadense 307
pallescens 293
papagonum 298
parvuliceps 296
perforatum 294
phœnicis 301
piceum 303
politum 302
probatum 310
procerum 297
prolixum 298
opacipenne 309
rufescens 302
rufopiceum 296
saginatum 296
sculptile 298
socium 295
subovale 307
subsimile 295
tersum 306
testaceum 303
truncaticeps 299
mexicanus, Arœoschizus 485
mexicanus, *Emmenastus* 515
mexicanus, Zopherus 461
Microdera 431
Micromes 432
maritimus 442, 443
ovipennis 442, 443
Miller, W. Lash 2
mimetica, Telabis 319, 326
Mitapsis 194
mixtus, Triorophus 440
mœstus, **Melanastus** 355
molestum, **Metoponium** 309
mosaic inheritance 211
montanus, Anepsius 505
morbillosa, Nosoderma 574
morosus, Zopherodes 465
morrosini, **Lobometopon** 393
mundulus, Triorophus 436
muricatula, Telabis 314
mutation 202
mutations, Mendelian inheritance of 220

nebulosus, Anepsius 507
neglectus, **Bothrotes** 407
Neism 201
Nephrodium 165
pseudo-mas cristata apospora 165
pseudo-mas polydactyla 165
nevadense, **Metoponium** 307
niger, *Schœnicus* 428
nigrans, **Steriphanus** 347
nitescens, **Steriphanus** 344
nitidus, Edrotes 452
Melanastus 355
nodiceps, Triorophus 439
nodulosus, *Zopherus* 463
normal diversity, relation of Mendelism to 230
Noserinus 470
annulatipes 470
Noserodes 470, 479
squalidus 481
Nosoderma 470, 474
æqualis 470
brevicollis 478, 479
championi 476
denticulata 469
diabolica 469
duponcheli 470
exsculpta 479
guatemalensis 481
inæqualis 476
longipennis 477, 479
morbillosa 475
plicata 469
prominens 478, 479
senex 479
sparsa 481
squalidus 470
subglabra 478
venusta 481
vicina 476
zunilensis 481
Nosodermini 281, 469
Noserus 469, 473
convexulus 474
corrosus 474
nucleatus, Useclus 484
nuperus, **Melanastus** 364
Nyctoporini 509
Nyctoporis 502, 509
æquicollis 512
carinata 511
cristata 502, 510
galeata 510
maura 512
pullata 510
segnis 511
sponsa 510
tetrica 512
nympha, Trimytis 368

obcordatus, *Boletophagus* 470
obesulus, Epitragodes 425
obesus, **Melanastus** 363

oblongulus, Edrotes 155
Hylocrinus (Locrodes) 337
obovata, Trimytis 370, 375
obscurum, Lobometopon 305
obsolescens, Bothrotes 411
obtusa (**Pimalius**) 367
obtusa, Telabis 317
obtusa, Trimytis 370
obtusus, **Melanastus** 356
occipitalis, Bothrotes 403
oculatus, Schœnicus 380, 381
Œnothera lamarckiana 209
lata 209
Omopheres 519
farctus 519, 521
Oogaster 282
(Oochila) 513
opacella, Telabis 316
opacipenne, Metoponium 309
Opatrum 282
Opuntia 175, 176
orbus, Edrotes 452
Origin and Evolution of Angiosperms through Apospory 159
Ortheolus 380, 381
osseus, Lepisosteus 80
otiosus, Melanastus 358
ovale, **Lobometopon** 395
ovalis, *Epitragus* 395
ovalis, Telabis 324
oviformis, Cryptadius 328, 329
ovipennis, Conœcus 431
Conœcus 380
Micromes 442, 443
Stibia 432
Stibia 442
Oxalis, trimorphism in 20
Oxygonodera 433, 444
grandiceps 446
hispidula 445
villosa 433, 445

Pachira 172
Pachychila 431
pallescens, Metoponium 293
pallidum, Chilometopon 375
papagonum, Metoponium 298
parallelus, *Emmenastus* 515
Paravius 332, 338
pardalis, Epitragodes 423
Parent gametes 197
organisms 197
Parepitragus 518
solieri 518, 520
partial dominence 209
parvicolle, Lobometopon 302
parvicollis, Zopherodes 466
parvuliceps, Metoponium 296
parvus, Melanastus 362
pavida, Telabis 324
Pechalius 379, 420
subvittatus 379, 421
Peireskia 175
Pellæa 172
pensus, Bothrotes 400
Penthicus 287
perditus, Bothrotes 409
perforatum, Metoponium 294
perforatus, Triorophus 433
Triphalus 447
Perjugate gametes, 195, 197
hybridism 215
organisms 197
reversion 212
peropacus, Steriphanus 349
perovatus, Steriphanus 351
perpolita, Metopoloba 415
Persea 172
pertinax, Bothrotes 405
Pescennius 367, 433, 517
Phegoneus 380, 426
jülichi 427
subvæneus 428
Phellopsis 470, 481
Phlœodes 466, 471
annulatipes 471
dormeanum 471
remotus 472
phœnicis, Metoponium 301
piceum, **Metoponium** 303
piceus, **Hylocrinus** 326
Hylocrinus (Locrodes) 336
picipennis, Bothrotes 406
picipes, *Emmenastus* 515
Pieters, A. J. 164
pilosus, Epitragus 397
pimalicum, Lobometopon 389
(**Pimalius**) 367
obtusa 367
pulverea 367
Pimelia rotunda 453
Pimeliopsis 450
pinguis, Emmenastus 289
Stictodera 353
placidus, Steriphanus 347, 352
Plantago 164, 175
Platamodes 282
Platamodini 282
platostomus, Lepisosteus 80
plicata, *Nosoderma* 469
plicatus, Cyrtomins 384, 385
plumbeum, **Lobometopon** 395
plumbeus, *Epitragus* 395
Podostemon 168
polar inheritance 204
polarity, prepotent 213
Polemiotus 379, 381
humeralis 382, 383
humeralis acuticauda 383
submetallicus 382, 383
Politism 207
politum, **Metoponium** 302
politus, Triorophus 435
polymorphism, subsexual 206
Polyodon and Lepisosteus, subcutaneous vessels in the head region of 79
Polyodon spathula 80
Posides 366, 517
prepotent polarity 213
Primula, semisexual dimorphism in 206
proba, Metopoloba 414
probatum, Metoponium 310
procerum, Metoponium 297
prolixum, Metoponium 298
Prometopion 366, 370, 375, 376
amplipenne 366, 372
helopioides 371, 372
prominens, Nosoderma 478, 479
Telabis 314
propinquum, Lobometopon 301

proprius, Steriphanus 350
proxima, Telabis 315
pruinosus, Epitragus 379, 417
pruinosa, **Metopoloba** 417
Trimytis 366, 368
puberulus, Schœnicus 380, 429
pubescens, Craniotus 458, 459
pullata, Nyctoporis 510
pulverea, **Pimalius** 367
Trimytis 370
pulvinatus, Emmenastus 515
pulvinatus, **Steriphanus** 352
punctatus, Emmenastus 289
Emmenides 330
Telabis 339
Triorophus 440
puncticeps, Edrotes 454
punticollis, Stibia 433, 448
punctipennis, Cryptadius 328
punctiventris, Metopoloba 414
punctulata, Telabis 312, 316

regularis, Arœoschizus 489
remotus, Phlœodes 472
reversion, conjugate 212
perjugate 212
Rhomboganoidea 80
Ricciaceæ, relation to Pteridophyta 161
Riella, relation to Cyathodium 161
mature sporangium described 16
rigens, Epitragus 381, 518
rotunda, Pimelia 453
rotundicollis, Batuliodes 497, 500
rotundicollis, Emmenastus 514
rotundus, Edrotes 453
rubida, Telabis 315
rufescens, Metoponium 302
rufipes, Eurymetopon 286, 288
rufipes, Schœnicus 428
rufopiceum, Metoponium 296
rugiceps, Triorophus 438
rugicollis, Emmenastus 515
rugosus, Emmenastus 287
rutilans, Steriphanus 346

Salax 282
Salaxini 282
sallei, Epitragus 381
salvini, Emmenastus 514
Schœnicus 428
Scalar inheritance 203
Schizillus 513
Schœnicus 380, 420, 428
basalis 428
chalybœus 428
difficilis 428
impressus 428
niger 428
oculatus 380, 381
puberulus 380, 429
rufipes 428
salvini 428
vestitus 378, 381
viridis 428
sculptile, **Metoponium** 298
Sechium 165, 173, 175
secutor, Bothrotes 406
secutor apertes, Bothrotes 406
segnis, Nyctoporis 511
semisexual dimorphism 205
senex, Nosoderma 479
seriatus, Emmenastus 515
seriatus, Trichiotes 432, 444
serrata, Telabis 325
Sesapsis 469, 470
setosus, Batulius 497, 499
sexual dimorphism 205
simplex, Arœoschizus 489
simplex, Triorophus 436
simulans, Arœoschizus 488
singularis, Typhlusechus 496
snowi, Metopoloba 416
socium, Metoponium 295
sodalis, Telabis 319
solidus, **Steriphanides** 515
solieri, Parepitragus 518, 520
solitarius, Emmenastus 514
sonoricus, Melanastus 364
sparsa, Nosoderma 481
spathula, Polyodon 80
Sphærocarpus, mature sporangium described 161
relation to Cyathodium 161
Spillman, W. J. 187
sponsa, Nyctoporis 510
Spoon-bill cat 80
spissicornis, Mesabates 517
squalidus, Noserodes 470–481
Stenocara 277
Stenosini 281
Stenosis 282
Sterculia 173
sterilis, Melanastus 357
Steriphanides 515
solidus 515
Steriphanus 289, 342
alutaceus 348
aridus 351
conicollis 349
convexus 346
discrepitans 343
discretus 350
hilaris 345
libertus 350
lubricans 345
lustrans 344
nigrans 347
nitescens 344
peropacus 349
perovatus 351
placidus 347, 352
proprius 350
pulvinatus 352
rutilans 346
subopacus 348, 352
unicor 346
Stibia 433, 448
hispidula 445
maritima 442
ovipennis 432, 442
punctcollis 433, 448
stictodera 289, 352
pinguis 353
stolidus, Emmenastus 515
Streptocarpus 171
striaticeps, Dacoderus 493, 494
subæneus, Phegoneus 428
subæqualis, Edrotes 456
subapterus, Emmenastus 515

Subcutaneous vessels in the head region of Polyodon and Lepisosteus 70
subglabra, Nosoderma 478
subhyalinus, Cnemodus 285
sublæviceps, Metopoloba 418
sublævis, Auchmobius 365, 366
submetallicus, Epitragus 379
Polemiotus 382, 383
subopacus, **Steriphanus** 318, 352
subovale, *Metoponium* 307
subpubescens, Triorophus 440
subrudis, Bothrotes 400
subseriata, Metopoloba 415
subsexual dimorphism 206
polymorphism 206
subsimile, Metoponium 295
subvittatus, Pechalius 379, 421
sulcicollis, Aræoschizus 488
supersexual dimorphism 207
symmetricum, Lobometopon 389

Telabis 288, 312, 326, 329
aliena 325
amica 318
aspera 322
blanda 326
brevicolle 514
compar 321
crassula 320, 326
curticollis 321
debilis 320
discors 313
famelica 323
fidelis 320
histrica 317, 326
incisa 322, 326, 327
inops 325
lobifrons 318, 326
longipennis 288, 313, 327
lustrella 323
mimetica 319, 326
muricatula 314
obtusa 317
opacella 316
ovalis 324
pavida 324
prominens 314
proxima 315
punctatus 339
punctulata 312, 316
rubida 315
serrata 325
sodalis 319
timida 320
uteana 317
vafra 315
vapida 322
Tenebrionidæ 276
tenebrosus, Bothrotes 403
tenebrosus, Emmenastus 515
Tentyria 431
Tentyriinæ, American Components of the 275
tenuicornis, Vacronus 501, 508
tenuis, Aræoschizus 486
Hylocrinus 333
tersum, Metoponium 306
terebratulus, Triorophus 436
testaceus, Cnemodus 284
testaceum, Metoponium 303
tetrica, Nyctoporis 512
texanus, **Armalia** 331
Emmenastus 289
Thinobatis 285
thoraciens, **Melanastus** 356
Thrinax 174
timida, Telabis 320
Tlascalinus 370
flohri 370
tomentosus, Epitragodes 423
Epitragus 380, 423
tonsa, Trimytis 369
Trichiotes 432, 443
seriatus 432, 444
Trientomini 278, 376
Trientomi **wickhami** 377
Trimytini 278, 282, 366
Trimytis 277, 366, 367, 375
abnormis 367
ignava 369
nympha 368
obovata 370, 375
obtusa 370
pruinosa, 366, 368, 370
pulverea 370
tonsa 369
Triorophini 279, 431
Triorophus, 339, 432, 434
basalis 437
brevis 439
gracilicornis 437
gravidulus 437
histrio 437
lævis 432, 435
lecontei 439
longicornis 438
mixtus 440
mundulus 436
nodiceps 439
perforatus 433
politus 435
punctatus 440
rugiceps 438
simplex 436
subpubescens 440
terebratulus 436
Triphalus 446
cribricollis 448
perforatus 447
tristæchus, Lepisosteus 80
tristis, Zopherus 461
truncaticeps, Metoponium 299
Tydeolus 380, 381
atratus 380
Typhlusechini 281, 494
Typhlusechus 496
singularis 496

umbrosus, Hylocrinus (Locrodes) 338
unicolor, Steriphanus 346
Usechini 281, 481
Usechus 482, 483
lacerta 482, 483
nucleatus 484
uteana, Telabis 317
utensis, Centrioptera 513

Vacronus 501, 508
tenuicornis 501, 508
vafra, Telabis 315

valens, Anepsius 504
vapida, Telabis 322
variabilis, *Emmenastus* 514
variabilis, Zopherodes 464
variolosus, Zopherus 463
vegrandis, **Melanastus** 360
ventricosus, Edrotes 450, 451
venusta, Nosoderma 481
Verbena stricta, color diversity in 206
Verodes 470
verrucipennis, Zopherodes 465
vestitum, **Lobometopon** 396
vestitus, *Epitragus* 396
vestitus, Schœnicus 378, 381
vicina, Nosoderma 476
vicinus, *Emmenastus* 515
villosa, Oxygonodera 433, 445
viridis, *Schœnicus* 428

Welwitschia (Tumboa) 171
wickhami, Trientomi 377

Zopherini 280, 460, 500
Zopherinus 461
  limbatus 461
Zopherodes 312, 461, 463
  californicus 466
  elongatus 466
  geminatus 467
  incrustans 464
  morosus, 465
  parvicollis 466
  variabilis 464
  verrucipennis 465
Zopherus 461, 462, 522
  chilensis 461
  nodulosus 463
  tristis 461
  variolosus 463
  mexicanus 461
Zophosiini 279
Zophosis 277, 287
zunilensis, *Nosoderma* 481

MBL WHOI Library Serials
5 WHSE 00870